

CHEMICAL & METALLURGICAL ENGINEERING

McGraw-Hill Co., Inc.

February 7, 1923

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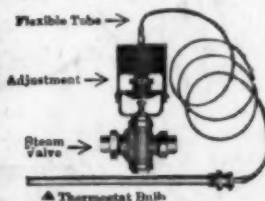
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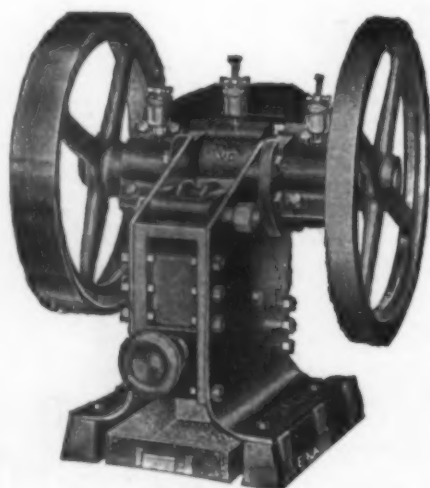
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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

H. C. PARMELEE, Editor

Volume 28

New York, February 7, 1923

Number 6

Bootlegging Is Developing The Fine Art of Smuggling

CONTEMPORARY philosophers, particularly those of a thirsty inclination, have often said that prohibition is responsible for making the United States a nation of criminals. In view of the widespread violation of the Eighteenth Amendment, we have never been disposed to controvert their argument. Recently, however, a prominent manufacturer of fine chemicals has called our attention to another phase of the prohibition problem that seems to carry with it a serious menace to certain of our chemical industries.

When an industry grows to tremendous proportions, byproducts often become sources of unexpected profit. Now, as bootlegging has gradually reached the stage of big business, it is perhaps natural that it should develop some profitable sidelines. One of these is smuggling, and along the coast lines and international borders an illicit traffic of no mean proportions has been developed within the past few years. It was recently stated in Congress, on no less authority than that of the State Department, that from the little islands of the Bahamas alone over 1,200,000 gallons of liquor is annually smuggled into the United States. As this traffic became established on such a large scale, and with comparative ease, it was not unnatural that the bootlegger should reach out for a profitable expansion of his business. With the same equipment that was required to bring in 50 or 100 cases of a material as bulky as liquor, he found that he could handle thousands of dollars worth of expensive drugs, pharmaceuticals or fine perfumes. To be sure, the risk was a little greater, the penalties considerably more severe, but probably these dangers served merely to add zest to the bootlegger's game.

Our manufacturing friend tells us that as a result of this diversion the country is being flooded with smuggled drugs—salvarsan being a particularly prominent example. Much the same condition also exists in the case of high-priced synthetics used by the perfumers and extract manufacturers. And, too, the dope and narcotic traffic continues without abatement.

That these clandestine importations threaten the very existence of American industries is obvious. Just what the domestic manufacturer can do to prevent them, however, is not so clear. He can insist on better enforcement, and can and should aid the federal authorities in ferreting out information regarding the origin and source of material believed to have been illegally imported. He should not lose sight of the fact, too, that under section 516 of the new tariff law the American producer for the first time in history has been given the privilege of appealing to the customs authorities for information regarding classification and appraise-

ment of competitive imported products. This is one very definite way in which the attention of the government can be centered on imports of questionable origin. In time, other procedures will doubtless suggest themselves, but it behooves the chemical industries to take immediate steps to put an end to this disastrous phase of the bootlegger's activity.

Pearly Gates For the Unregenerate

IN the last October number of our French contemporary *Chimie et Industrie*, MM. CLÉMENT and REVIÈRE announce their achievement of synthetic mother-of-pearl. The pearl oyster, it appears, secretes an albumenoid material called "conchyoline," which contains calcium carbonate and water, and the authors found that when calcium carbonate is precipitated in a colloidal medium under certain conditions, it forms a network of particles which displays the optical phenomena of a grating. Salts of other metals show similar but less pleasing effects owing apparently to the finer grain of the calcium carbonate.

We confess to a sense of shock about this invention. We didn't mind the corrugated domestic rainbows brought out on so-called Tiffany glass years ago. But this is different. We went to Sunday School with diligence and learned our lessons to the end that we might eventually march in triumph through gates of just such pearly splendor, get an equipment of wings and a harp, and proceed to enjoy ourselves with a definite quality of distinction. Now along come these two Frenchmen with their precipitated calcium carbonate, and before we know it some movie magnate from Hollywood who never went to Sunday School will set up a "palatial residence" across the way, and in front of it will be the very pearly gates of our young desire—and no brimstone pit at the left entrance for our dearest enemies. It's too bad.

Beyond the Control Of the Directors

AT THE general meeting of the stockholders of the Magadi Soda Co., Ltd., held in London on Dec. 11 last, S. SAMUEL, the chairman of the board, said that "the very unsatisfactory position of the company had been brought about by causes beyond the control of the directors. Production had been hindered throughout by the failing of machinery and the fixing of the rate of exchange at 2 shillings to the rupee."

This brings up a very interesting question. Was the failure of the machinery wholly beyond the control of the directors? We admit the rate of exchange was. Suppose the accounts had not been properly kept and at the annual meeting they would have been unable to

tell what their assets and liabilities were. Would that have been "beyond the control of the directors"? It would not, and yet directors are not chosen because they are expert accountants. Suppose they had neglected to make sales, although there was a good market. They would have been to blame, and yet they were not all chosen because they were alkali salesmen. Then why was it beyond their control if the machinery they bought was improperly designed or improperly chosen? The decision to purchase certain equipment is just as much a part of their business as is keeping accounts and selling their product.

Later in the report we read that "the defects of the new bucket-dredger which had been sent to Magadi had now been made good and the dredger had been restarted; in a few weeks there would be a minimum production of soda at the rate of 100,000 tons a year." Why wouldn't the bucket-dredger work when it was set up? Evidently because it was improperly designed for the work in hand. Maybe a member of the board who doesn't know anything of technology bought it from an officer of a machinery company who knows nothing of soda production.

The chairman of the board made an error that is even more common in this country than it is in England—namely, that ignorance of technology is excusable among the directors of a manufacturing corporation. In point of fact the board of a corporation is a unit. No one man can know everything. To have a consultant on call will not solve the problem, because those who are not properly informed do not know when to send for him. It is just as important to have a competent technologist among their number, to avoid such mistakes as this, as it is to have men who can read a balance sheet. Then these mistakes will not be "beyond the power" of directors. The condition will be within their control and the errors will be avoided.

Growing More

And More Helpless

CONGRESSMAN RAINEY of Illinois declares that there are now on the federal payroll and on state and municipal payrolls, and pensioners and others who are maintained by taxes, about 3,350,000 men and women. That would indicate that 15,000,000 persons in the United States live on taxes collected from their fellow citizens. There are only 30,000,000 of us engaged in productive labor. Therefore every two persons so engaged support besides their own families at least one man, woman or child by the taxes they pay. If they don't pay it in taxes they pay it in rents or other living expenses.

In 1897 there were 167 federal deputies, agents, etc.; in 1907 there were 3,000, and in 1922 there were over 30,000 federal deputies, agents and inspectors on the government payroll. Within the last 65 years federal taxes have increased from 46 cents to \$30 per capita. The latest plan for adding to the tax burden is to collect the British debt on the best possible terms and then blow in the whole four or five billions on a soldiers' bonus.

What are we going to do about it?

No matter what we think as individuals, these plans may go through. Politicians respond to what they think is public opinion, and this noise to which they are obedient does not contain as yet any intimation that taxes raise rents and living expenses. The noise demands

that commissioners be appointed to examine into and control nearly everything there is. The politicians obey.

When this government was organized there was THOMAS JEFFERSON, who held that the people should manage their own affairs and that we should have as little government as possible. ALEXANDER HAMILTON, on the other hand, upheld the idea of a strong central government to control affairs. Both were philosophers and thoughtful men. We have discarded JEFFERSON and followed HAMILTON, which might have been well enough if we had only kept our wits about us. But we followed thoughtlessly. We demanded government control of anything and everything until now it has become a burden. As an example, the Bureau of Indian Affairs supports between 5,000 and 6,000 employees to look after 200,000 Indians, and the Indians are suffering from lack of intelligent and conscientious attention. Nevertheless this same bureau asks for an appropriation of \$13,000,000 for the coming year. The government is fairly choked with just such abnormal growths on various parts of its system.

Some day the pendulum is bound to swing back for the same reason that a rocket that goes up must come down. We as a people shall grow tired of the infernal cost of so much government. The noise will say so, and the politicians will proceed to cut and slash. They will not do so intelligently, because it is the habit of politicians to address themselves to window-dressing rather than to look ahead beyond the next election. So we would better prepare to manage our own affairs without government support. This simpler and less expensive and less helpful and less meddlesome government may be slow in coming, but it is bound to arrive some day. It will be wise for us to consider our situation beforehand.

Smoke Damage

And Chimney Height

ON page 1220 of our issue of Dec. 20, 1922, we published a brief abstract of a decision on a smoke suit dating back to 1917, in which the plaintiff was given a judgment for some damage incurred while the flue system of the St. Louis Smelting & Refining Co. was under reconstruction. Unfortunately, however, the caption of the note stated that "Doubling Height of Smelter Stack Causes Fume Damage."

Our readers will doubtless recognize in this one of the slips and errors which happen to any organization of mere humans. Those interested in smoke have followed our very full accounts appearing during the last 5 years of investigations on that problem. These researches have established so clearly as to be beyond reasonable doubt that no crop damage results from SO₂ fumigation except when definitely known concentrations are exceeded for definitely known times and under optimum conditions of sunlight and humidity. In other words, sulphur is successfully eliminated from a smelter system by correct dilution of the flue gases into the surrounding atmosphere before the smoke stream touches the ground. It is self-evident that this dilution increases with the temperature of the gases and the elevation at which they are discharged.

Therefore the possibility that crop damage could be increased by doubling the height of a stack—other conditions remaining the same—is so remote that those cognizant of the smoke situation would unconsciously appraise our headline as an error.

The Raging Battle Of the Oil Titans

THE greatest legal struggle in the history of American industry is now going on in an effort to decide what is what and who is who in the oil-cracking business. Hundreds of millions of dollars are involved, a money value with which there are few comparisons. Tales of Captain KIDD'S treasure chests or even stories of the fortunes of modern bootleggers would have to be put through at least a seven-stage radio amplifier to be heard in this battle of the oil Titans. We are now producing annually about six billion gallons of gasoline in this country. Imagine the great, green depth of Niagara Falls roaring away for about 45 minutes and one may perhaps visualize our annual gasoline production. The proportion of "cracked" to straight-run gasoline made from the crudes is rapidly approaching a one-to-one ratio. Fuel oil passed through an efficient cracking plant is enhanced in value about 6 cents per gallon.

Why the big fuss? Simply because the elements of oil cracking, heavier hydrocarbons to lighter ones, were discovered when present-day graybeards were living in "The Days of Real Sport" with Skinnay and the Pup. Coupled with the general situation is a crippled, sadly underpaid Patent Office. That gasoline was produced in substantial quantities by the old-fashioned cracking processes was reported by Prof. C. F. CHANDLER away back in the pre-bicycle age. And we moderns know too that a very large part of what is now included in the gasoline or motor fuel fraction was formerly run into the kerosene fraction. True the yield of gasoline is increased and its quality is improved by distilling or cracking under pressure, but KREY, DEWAR and REDWOOD and others developed processes of this sort back in the lower Pleistocene. And now, too, interested people are discovering that fossil apparatus discovered in the chalk cliffs of Bayonne and other points can be operated so as to produce gasoline. Furthermore, it is rumored that some of the curious markings on papyri carefully preserved at the Patent Office have been made to blossom, like Japanese pith flowers, into working drawings of gasoline-cracking apparatus.

To one who is not a Jack-be-nimble lawyer, and not gazing into a crystal, several things appear to stand out as real. Somebody must have had to dynamite away a deal of conservatism and start the thing going—show that marketable cracked gasoline could be manufactured in a big American way, and at a cozy profit. It seems to us that this was WILLIAM M. BURTON. To a casual reader of the daily papers it appears that Burton stills have been known to blow up when you didn't want them to. We understand that one of the big troubles has been the formation of carbon or coke. We are told that many forms of apparatus have been built, some with the tubes running north and others west, but the carbon deposits just the same. Then somebody discovered that if the oil is heated hot enough and then passed into a receiver, insulated so not to lose the heat, the cracking proceeds for some time and most of the coke forms and is deposited in this insulated chamber, removed from the heating surfaces. It seems that this principle is made use of by CROSS and by DUBBS.

The legal struggle has settled down to four or five major contestants, each with an impressive rosary of patents. In the meantime, conditions in the industry have become such that it is practically imperative for

a refiner to "crack" or be cracked. The freedom of the whole industry is, to a large degree, at stake. If the courts should hold that one or two of the earlier live patents, now in litigation, are basic, then the whole industry will have to pay tribute. Ten cents per barrel of stock treated is the royalty proposed by one concern.

It seems likely, at least we hope, that out of this great polygonal debate will come a clarification of our patent law, the establishment of new precedents as to what is patentable matter. We have noted the recent decision, after appeal, in the case of the Saybolt patents for absorbing gasoline vapor under pressure from natural gas, that the said process and patents merely set forth certain simple and widely understood principles of physics. How long will American industries tolerate \$2,000 patent examiners to grind out confusion for the \$15,000 judges, to the delectation of the \$50,000 lawyers and the despair of those who pay for it all?

Awaiting Operating Data On the Colloid Mill

ABOUT 30 months ago the first article on the colloid mill was published by its inventor, Dr. HERMAN PLAUSON. From this and subsequent articles we have built up our present conception of a grinding mechanism that has attracted world-wide attention. The idea seems to be to subject a substance suspended in liquid to the extreme disintegrative action of teeth set on a cylinder which rotates at high speed and drives the particles against stationary teeth set on a concentric shell. The cylinder is designed to operate at very high speed, claims having been made of an attained peripheral speed of 650 ft. per second and a possible speed of over 3,000 ft. per second. This is the so-called impact type mill, which, together with the friction type mill, was described in detail in our issue for Jan. 10.

There seems nothing impossible in the conception of such disintegration. To anyone who has worked with dye pastes or other substances where fine subdivision is essential, a mechanical disintegrator is conceivable. But the stumbling blocks in the way of complete optimism regarding its utility are incidental to the terrific speed that is necessary. First, there is the wear and tear of heavy work at high speed. Of course in a machine like the Sharples supercentrifugal we have speeds which the colloid mill probably would not reach; but the supercentrifugal has a relatively light cylinder rotating in air, while the colloid mill must have a heavier cylinder operating in a liquid. If the mill is used to make actual or near colloidal solutions, the liquid would often be viscous. As a matter of fact, in terms of 1,000 r.p.m., any liquid is viscous. Then the mechanical details of construction of such a mill on a commercial scale offer a formidable problem. Of course it is not impossible, but it presents such difficulty as to make commercial success almost a greater achievement than the invention itself. Finally, after the mill has been made a mechanical possibility, the high operating cost for power and the replacement cost of worn parts due to heavy wear and tear present operating difficulties that suggest a distinct economic handicap.

So far there are no existing data on the operation of the mill and they are being awaited with interest. The difficulties outlined here are not regarded as insuperable; they merely indicate the very definite engineering problem that must be solved before the mill can be a success.

Readers' Views and Comments

Accelerated Reactions in Pulsating Gaseous Currents

To the Editor of Chemical & Metallurgical Engineering

SIR:—I read the article by Deschamps and Shadgen with some interest when it appeared, and thought at the time that their proposal seemed *a priori* reasonable and well worth a trial. I am afraid that I could not usefully comment on it for publication, however. The authors might be interested in a paper given at the recent New York meeting of the A.S.M.E. by Judd and Pheley; it seems that pulsations in a current of gas flowing in a pipe raise the reading of any common metering device, possibly by absorption of a part of the energy of the compression waves. In an open reaction chamber, where such pulsations would not be too rapidly killed by interference, it seems possible that a rise of reaction speed would be brought about in an analogous way.

Research Department,
Brown Company,
Berlin, N. H.

W. B. VAN ARSDEL.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your number of Dec. 27, 1922, appears an article by Jules Deschamps and J. F. Shadgen on "Accelerated Reactions in Pulsating Gaseous Currents." This is very interesting, but would be much more convincing if it contained some numerical data to substantiate the theories advanced.

Since no such data are included, the writer feels emboldened to venture some speculations of his own with respect to the processes occurring in the interstices of the packing of an absorption tower.

In the example cited, of the behavior of an irregular packing with respect to gas flow, it is difficult to see why channels which are dead under a uniform gas flow should not be nearly as dead under fluctuating flow. Certainly if the gas flow is maintained uniform and is increased to two or three times the unit flow, the same relative amount of gas would pass through any given passages. Why, then, should a sudden increase in flow of less than two times the original unit flow (it is assumed that such pulsations as the authors have in mind are less than 100 per cent of the normal flow, though no statement with regard to this is made) cause any change in the relative amount of cross-flow?

Granting that such pulsations actually produce improved absorption, the writer believes the improvement is probably more easily explicable on the basis of better liquid distribution than on the assumption of the bringing into play, so far as the gas phase is concerned, of dead cross-channels. A sudden increase in gas velocity through certain channels already carrying liquid almost to the loading point would cause a damming up of liquid at this point, whereupon the dammed liquid would tend to back up and flow through a dead cross-channel to a vertical channel having a gas velocity below the loading point. Gas pulsations might thus tend to prevent channeling of the liquid and might thus increase the efficiency of the absorption apparatus by effecting more intimate contact between the liquid and the gas. This explanation seems much more plausible to the writer than the one advanced by the authors.

It is, moreover, also conceivable that pulsations in the gas current would tend to renew the gas standing in dead pockets, by causing a surging back and forth in such a pocket, and would thereby bring into play gas spaces which would otherwise remain dead, but such surges, under operating conditions, would be so minute as to be insignificant.

Of course the proof of the pudding is in the eating, and in this case the important thing is the amount of improvement that can be brought about in a gas absorption apparatus by impressing pulsations on the gas stream, rather than an immediate elucidation of the principles involved. It is to be hoped, therefore, that the public will be favored with an early statement of some of the quantitative results obtained in actual practice.

F. C. ZEISBERG.

The du Pont Company,
Wilmington, Del.

Rapid Analysis Of Aluminum Alloys

To the Editor of Chemical & Metallurgical Engineering

SIR:—With the widespread use of aluminum castings and the great interest in hardened aluminum forgings, the laboratory is now frequently called upon to analyze such materials. Published methods often used require far too long for industrial application. Consequently the following methods—which I have used for some time and which have been checked against reliable time-consuming methods—may be of considerable interest to your readers:

Manganese. Weigh 0.5 gram sample of drillings or turnings into 250-cc. beaker, tall form, add 50 cc. of 1:1 nitric acid and heat to solution, keeping beaker covered with a watch glass. Solution of alloy requires about 25 minutes. When solution is complete, add 150 cc. of distilled water. Then add 3 cc. of silver nitrate solution (30 grams AgNO_3 and 375 cc. HNO_3 per liter) and about 1 gram of ammonium persulphate. Heat gently, but do not boil. As soon as color develops fully, which takes place below boiling temperature, remove from hot plate. When cool, titrate with standard sodium arsenate. 1.0 cc. = 0.050 per cent Mn based on 0.50 sample.

Arsenate solution can be readily standardized against a standard steel sample of known manganese content in the usual way.

Copper. Weigh 1.0 gram sample into 200-cc. beaker, tall form, and bring into solution as before. By the time sample is in solution the volume of the solution will be reduced by about one-half. Add 100 cc. of distilled water and 10 cc. of 1:3 H_2SO_4 . Remove the copper by electrolysis, plating it out on a weighed platinum gauze electrode. When copper is all deposited, which can be determined by diluting solution somewhat with distilled water, raise electrodes out of solution without breaking the current, wash down with distilled water, remove water by dipping electrodes in alcohol. Dry and weigh the electrode and calculate the percentage of copper.

G. W. WALKER.

Hupp Motor Car Corporation,
Detroit, Mich.

A Protest

To the Editor of Chemical & Metallurgical Engineering

SIR:—The American nation is, I am told, specially courteous to women. I take it therefore for granted that you will publish in full this letter.

Friends have put before me pages 776 and 777 of your journal for Oct. 18, 1922, and I am assured that your paper has a wide circulation among American engineers and chemists. To my great astonishment my cartoon which appeared in the *Fliegende Blätter* has been reprinted without my permission and has been explained at the same time in a way which excels the misrepresentations disseminated during the world war in the Northcliffe and other press of the former enemies of Germany. The following explanation of my satirical cartoon may suffice:

The *Fliegende Blätter* is an entirely non-political paper, which ridicules and condemns human weakness of every kind. Vox populi means the voice and judgment of the masses in all countries of the world. Nowadays people are generally not guided by leaders of a supernormal intellect, intelligence and very high qualification, but in the first instance the mind of the masses is dependent on the press, the influence of which is increasing everywhere.

The fallacy of human leaders is proved by the downfall of Woodrow Wilson in your country and Lloyd George in England, not to speak of the German leaders in 1914 to 1918. The press leading the masses is imbued with phrases and catchwords. The owners and governors of the press are rarely guided by ideals, but mostly by egoistic thoughts. The masses are like a flock of sheep (*Hammelherde*), who follow the guide-wether (*Leithammel*). In a great many countries the "Leithammel" of the press are "wolves in sheep's clothing," who feed the sheep with phrases and catchwords. This, my general impression of all countries, was pictured in my cartoon. I regret that such long interpretation is necessary to prove that the author of your article has not understood the proper meaning of the word "vox populi" and of my cartoon and that a journal of your position and reputation has published such wrong judgment of my country without consideration of the true state of affairs in all countries.

KÄTHE OLSHAUSEN-SCHÖNBERGER.

Munich, Germany.

EDITOR'S NOTE: We gladly grant space for our correspondent's explanation. Our interpretation of the cartoon still seems particularly fitting to conditions in Germany, where the masses have been exploited by a few industrialists.

Numbering of Steel

To the Editor of Chemical & Metallurgical Engineering

SIR:—It is curious how variously a piece of writing can be viewed. Your editorial of Dec. 27 leaves one of your correspondents dizzy from your persiflage, while to some others of us it appears to be a sensible constructive review of the situation.

The question of numbering or codifying steels is of considerable importance. But if it is to be discussed intelligently, every proponent of a numbering system should start by stating quite definitely the purposes to be served by the system.

To my mind there are two main spheres of usefulness for a numbering system:

(1) A manufacturer who makes machine parts and purchases semi-finished steel bars, blooms, etc., of vari-

ous grades and desires to give each grade of steel a designation so that it may be readily recognized and referred to, to the end that the correct steel shall be selected and used for each part to be manufactured.

(2) A designer wishes to use on his drawings a simple notation which shall show the kind of steel to be used for each part.

These two applications are to a certain extent overlapping and in practice will be subject to many minor variations and developments. They do, however, show the essential characteristics required of any useful system of designating steels. Both uses lead eventually to the purchasing agent, and in this fact lies the necessity that the numbering system to be really useful must be perfectly definite. Suppose that under a system applied to our No. 1 purpose, the stock of a given steel is running low and the stock clerk requisitions 100 bars 4 in. square by 10 ft. long of *XYX* steel. The designation *XYX* is sufficient and satisfactory if it enables the clerk in the purchasing department to fill out as a matter of simple routine a request for bids or an order which will indicate without further question the steel required. To my mind this can be done only by having the symbol *XYX* represent a complete and definite specification. A symbol which merely indicates the general proportions of the principal elements is useless to the purchasing agent. To place his order intelligently he must have an open-or-shut specification on which he can accept or reject without argument.

Similarly for our No. 2 purpose. To fulfill the designer's needs the designation on the drawing must leave no doubt as to the properties of the finished piece. These must be so clearly expressed that it becomes a routine matter to select the raw material and to choose the processes it is to undergo to give the desired results. Again the symbol designating the steel must lead to a complete specification.

It is evident that for semi-finished material (our purpose No. 1) the numbering will in most cases lead only to a specification as to chemical composition, while for finished parts (our purpose No. 2) the specification must usually cover physical properties with some indication as to the chemical composition, but in both cases the numbering to be of practical value must give a concrete, definite account of the steel it describes.

LAWFORD H. FRY.

Standard Steel Works Co.
Burnham, Pa.

Studies on Graphite Crucibles

In order to investigate the crucible-making properties of American graphites as compared to foreign graphites, seven sets of crucibles, six to the set, were made by the Vesuvius Crucible Co., according to a formula furnished by the Ceramic station of the Bureau of Mines.

In arriving at this formula, the bond clays were varied and the Ceylon graphite kept constant. Crucibles made from the most promising mixes were tested in steel-melting practice at the Lockport, N. Y., plant of the Simonds Manufacturing Co. Some of the crucibles gave ten melts before failure, which is considered excellent practice.

Using the most promising mix of bond clays and graphite obtained in the above-mentioned tests, seven sets of crucibles were made up using seven different graphites and are now awaiting test. The graphites used were Ceylon, Madagascar, Alabama, New York, Montana, Texas and Canadian.

How "Asbestos-Protected Metal" Was Developed Commercially*

By J. H. YOUNG

Senior Industrial Fellow, Mellon Institute of Industrial Research,
University of Pittsburgh, Pittsburgh, Pa.

The Early Stages of Development and the Peculiar Problems Which Had to Be Solved Before the Product Became a Commercial Success—The Process of Manufacture—Some Still Unsolved Problems

THERE are two fundamental problems with which man has had to contend since time prehistoric. Man's first duty has been to provide food and his second to provide shelter. Accordingly, the general subject "building materials" is not one which is impressive by its newness; it is one which has been with us always and that always will remain. However, with the advent of the modern factory and chemical industry, there have come some novel phases of the subject which are of interest to the chemical engineer.

As a rule, the chemical engineer has busied himself with chemical processes and equipment and has given but little attention to the selection of the proper building materials to house his industry. This constructional task has been left to the architect; and although this specialist has conscientiously done his best and, as a rule, has made wise selections of his materials, his training does not fit him for meeting the many problems connected with the proper housing of the various and highly diversified chemical industries, without advice from those who should be peculiarly well qualified to render such aid—namely, the chemical engineers. In times past this advice has been neither sought nor offered. As one result, buildings containing much lead in their structures have been erected to house industries in which high concentrations of acetic acid prevail in the atmosphere. Concrete, copper, aluminum, zinc and steel—in fact, all building material—have limitations and have been used under conditions for which they are not adapted. Therefore the chemical engineer may quite profitably study the materials available for his buildings as well as those used in its equipment.

During the development and expansion of the steel industry corrugated steel sheets, either the so-called black-iron or the galvanized iron sheets, have come into very wide use as a roofing and siding material on industrial buildings. The comparatively short life of these sheets has led to the development of a number of useful roofing and siding materials for industrial buildings, each of which nevertheless leaves something to be desired. In other words, the perfect roofing and siding material is yet to be evolved. Among the comparatively new roofing and siding materials which have been developed is the so-called asbestos-protected metal and it is particularly with this product that this paper deals.

EARLY STORY OF ASBESTOS-PROTECTED METAL

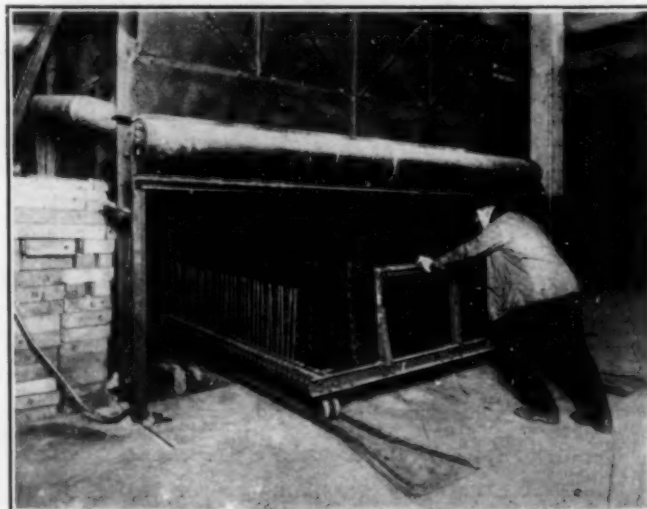
The early history of many American industries teems with tales of struggles against great odds. The surviving manufacturers usually owe final success to the courage, faith and active optimism of a single individual who has never recognized defeat when he encountered it. Such has been the case with the asbestos-protected metal industry. Starting in 1905, at Canton, Mass., with an idea that a steel sheet could be protected

from corrosion by dipping it in molten asphalt and then pressing a layer of asbestos felt on each side of the coated steel to protect the asphalt, H. H. Robertson stuck by his idea through thick and thin, and there was considerable thin until the present product was evolved.

As may readily be imagined, the original product was a failure, the asbestos felt rapidly washing from the sheet upon exposure and collecting in the roof gutters or on the ground. To overcome this difficulty, the asbestos felt was saturated with a waterproofing mixture, of which chinawood oil was the principal ingredient. The resultant product was considerable improvement over the original material and really gave pretty good service. However, the edges and ends of the steel sheet were unprotected, and this resulted in a weakness which was finally overcome by folding the felt over the edges of the steel.

Commercial success was not achieved until 1909, when the late Dr. E. T. Newsome developed new machinery which made it possible to manufacture a product consisting of a sheet steel core covered with asphalt and wrapped in asbestos felt saturated with a waterproofing agent. This product of 1909 won commercial success, but although it had sufficient merit to warrant its sale, it was considered to be a long way from perfection. It may be added, though, that there are a number of installations of this 1909 product which still are serviceable.

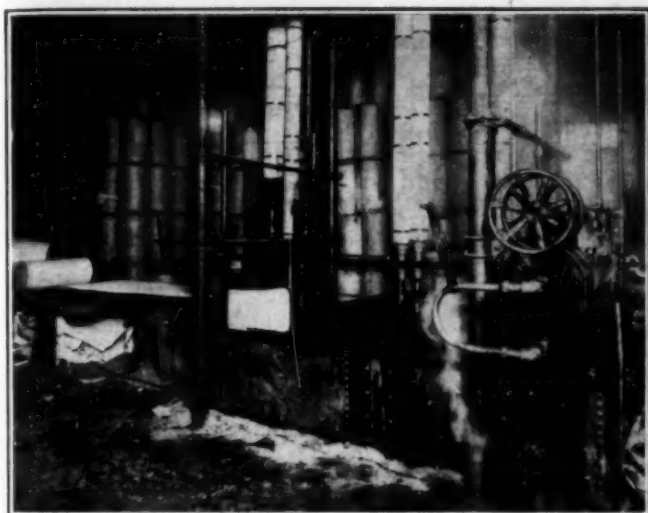
Recognizing that improvements were possible in its product, the manufacturing company adopted the policy, which has since been adhered to, of utilizing a part of its resources each year in development work. As a result of the researches carried out during the period 1909-1916, the present product was worked out and pro-



DRYING THE CELLULOSE THIOCARBONATE SOLUTION

This produces the film of cellulose hydrate on the surface of the asbestos-protected metal.

*Paper presented at the Richmond meeting of the American Institute of Chemical Engineers, Dec. 6-9, 1922.



SATURATING ASBESTOS FELT

duced in 1916. This product differs from that of 1909 in that asphalt is used to saturate the asbestos felt and the felt layer itself is protected by a bituminous coating which retards the drying and hardening of the bituminous layers beneath, thus increasing greatly its weather-resisting properties.

The original asbestos-protected metal was made in Canton, Mass. In 1911 the company moved to Beaver Falls, Pa., and in 1916 the present factory at Ambridge, Pa., was occupied. Factories in Canada and England were then added.

WHAT IS REQUIRED OF ROOFING AND SIDING MATERIALS

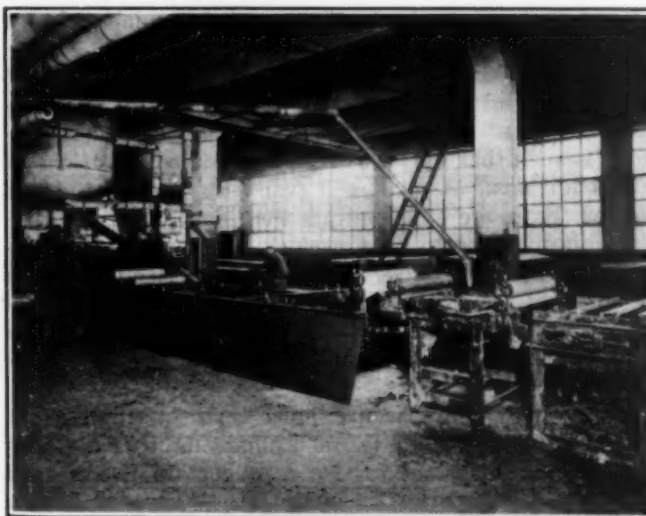
Before taking up in detail the discussion of asbestos-protected metal, it is appropriate to present an opinion respecting the requisite essentials in the perfect roofing and siding material. When a roofing and siding material is referred to, there is meant the type represented, for instance, by corrugated galvanized iron which is used to cover the so-called skeleton type building.

It is believed that the perfect roofing and siding material, in order to meet various and complex requirements of roofing service, should have the following characteristics: (1) It should have strength; (2) it should be resistant to weathering; (3) it should be light in

weight; (4) it should be adaptable to buildings of standard design; (5) it should have a low fire hazard; (6) it should have a low thermal conductivity; (7) it should be capable of conforming to any color scheme required; and finally (8) it should have a reasonable first cost and a low per year cost.

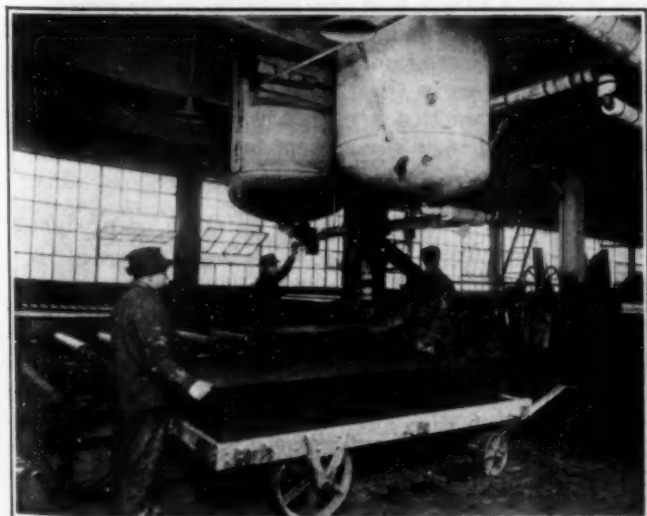
Since steel is the basis of asbestos-protected metal, the strength requirement is well taken care of. By choosing steel of the proper gage, it may be made to span successfully any purlin spacing ordinarily used. The weight of asbestos-protected metal is approximately 1.3 times the weight of galvanized iron. Being similar in form, strength and weight to ordinary corrugated steel roofing, it will span with a wide margin of safety all standard purlin spacings, and may be worked into flashings and other standard shapes. It is easily adaptable to the general run of mill buildings without the necessity of designing the buildings to meet any limitations of the roofing material.

In order to get a better idea of the durability of this product, it is necessary to describe the various protective coatings used over the steel and the methods of applying them. The first and most important bituminous coating is applied by pulling the clean steel sheet



THE OTHER SIDE OF THE COATING MACHINE

Showing cooling tank for cooling the asphalt coating and the tank for applying the solution of cellulose thiocarbonate.



THE COATING MACHINE

Starting the so-called felted sheets through the coating rolls which put on the weatherproofing coat.

through a vat of the asphalt maintained at a temperature of 350 deg. F. The viscosity of the asphalt at this temperature is such that a uniform coating weighing about 16 lb. per square (100 sq.ft.) is put on the steel. As the coated steel emerges from this tank, asbestos felt, previously saturated with asphalt, is pressed on to both sides and folded around the edges of the steel, thus completely sealing it. The next operation consists of running the so-called felted sheets through coating rolls, which apply the top waterproofing coat. The coating rolls operate at a temperature of about 425 deg. F. The whole process is one in which no solvents are used, the asphalts being applied in a melted condition.

The asphalt used directly on the steel is an air-blown petroleum asphalt having a low susceptibility factor, being soft and adhesive at low temperatures, yet not flowing at temperatures reached on roofs, even in the tropics. It contains practically no mineral matter and is chemically quite inert, particularly toward acids and slightly less so toward alkalis.

The saturant for the asbestos felt is also an air-blown



FEEDING STEEL SHEETS INTO THE FELTING MACHINE

asphalt of the asphalt-base petroleum type, and it is also quite inert chemically.

The top or weather-proofing coating is a compounded bitumen, being of the so-called stearin pitch type. It is similar in composition to the best baking japan bases and withstands weathering conditions very well.

It is clear, then, that there are three layers, each of which is of bituminous composition and is of substantial thickness. The chemical nature of these compositions is such that they will resist a wide range of chemical conditions. Asphalt will resist the chemical action of a wider range of chemicals than any other commercial adhesive known at present. A study of the performance of the product under actual service conditions of all sorts and in all climates show that it is a relatively durable building material.

FIRE HAZARD AND CORROSION

Regarding the fire hazard, since each square of metal has approximately 36 lb. of asphalt on it and since asphalt is combustible, there is a certain fire hazard involved in the use of the material. Where used on a roof, the hazard is of little consequence, because of the fact that burning embers and the like, falling on such a

roof, will fail to produce a spreading fire. In other words, the asphalt has such a low combustion rate that the heat is dissipated upward too rapidly to keep the film burning and the fire is localized at the spot where the ember falls. In case of a side wall a fair-sized fire at the base may ignite the coating, and the coating under favorable conditions will continue to burn upward until the roof is reached; but the damage done consists of the loss of the protection to the steel sheets, which may still give some service if painted.

While the fire hazard of a roofing and siding material is an important factor to be considered, it is interesting to note that the loss from so-called slow burning or corrosion is several times as large each year as the loss from fire. One gains much food for thought in looking over the long list of so-called fireproof buildings which have burned each year. Truly the fire hazard is important, but the corrosion hazard is of equal if not greater importance.

In general, it is quite important to have a roofing and siding material with a low thermal conductivity, because a building housed with such material is heated with less

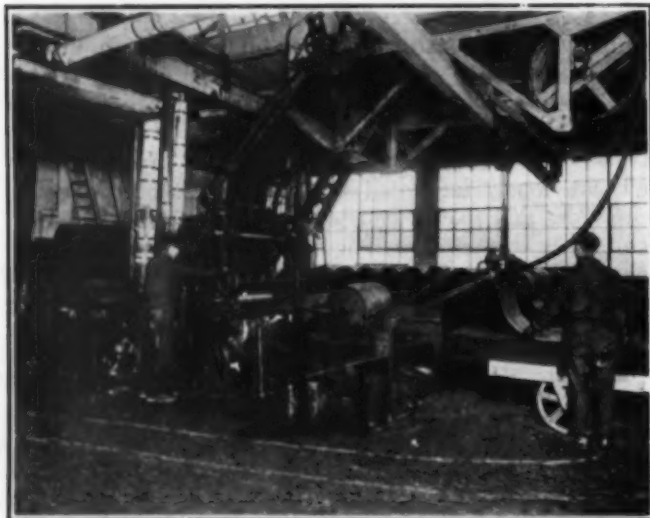


THE CORRUGATING MACHINE

expense in the winter and is cooler in the summer and also because it transmits sound less readily, as a rule. Asphalt is among the very best non-conductors of heat, and it is safe to say that the material under consideration is as poor a conductor of heat as any material of equal thickness used for roofing and siding purposes. Its deficiency lies in the fact that it is not very thick; but in actual practice it compares very favorably with $\frac{1}{4}$ in. pine wood in so far as heat loss is concerned.

THE PROBLEM OF COLOR

Coming now to the subject of painting or producing various color effects on or with it, it is confessed that, outside of dark colors, such as maroon, dark green and brown, it has been impossible to produce colors satisfactorily, either by painting or by incorporating pigments in its outside coating. White or light-colored drying oil paints or enamels, when used over bituminous surfaces, become discolored by dissolving the dark bituminous coating; then, too, the paint films tend to distort the underlying bituminous material, producing an effect commonly termed "alligatoring." If a priming coat of shellac or other similar gum is applied to a bituminous surface, a drying oil paint may then be put on without becoming discolored, but, upon exposure, cracking and



THE FELTING MACHINE IN OPERATION

The steel sheets travel through hot asphalt and upward through combining rolls which press asbestos felt onto both sides of the steel sheet and fold the edges of the felt around the steel, forming a continuous web.

"alligatoring" take place. For interior finishes a fairly satisfactory result is obtained by the shellac priming-coat method, provided either a cold-water paint or a drying-oil paint is used over the shellac. A Manila copal spirit varnish may also be used as a priming coat. A cellulose nitrate lacquer has been developed in which alcohol is the principal component of the solvent. This lacquer is satisfactory as a priming material, and with aluminum or bronze powder it will produce a satisfactory light- and heat-reflecting finish that weathers fairly well, without cracking or distorting the coating. It may be seen that, although it is possible to produce several light color effects, they are all more or less of the make-shift variety. It is true, however, that on the vast majority of buildings of the type covered by similar materials dark colors are not objectionable; indeed, they are often preferred.

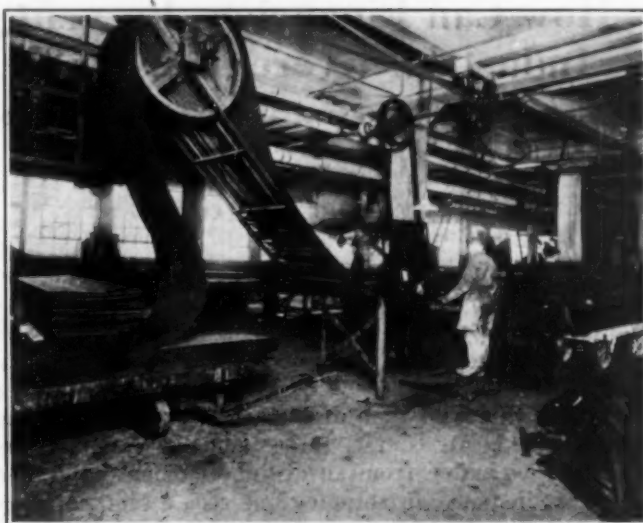
Taking up finally the factor of cost, it may be said that asbestos-protected metal compares very favorably in first cost and in per year costs with material used for the same purpose. Erected, it costs from one and one-half to two times as much as painted galvanized iron; but on a per year basis the cost will average very much below that of painted galvanized iron, when its low maintenance cost is considered.

Summarizing the characteristics of asbestos-protected metal, it may be stated that it is strong, durable, adaptable and light in weight, and has a fairly low thermal conductivity. It has a certain fire hazard, and is not capable of being painted satisfactorily with drying-oil paints. It has a relatively low first cost and a low per year cost.

SOME RESEARCH PROBLEMS, SOLVED AND UNSOLVED

In the development of any industry it is natural to expect a variety of problems to arise, and often they come from quarters least expected and at most inopportune times. One such problem appeared when the present type of asbestos-protected metal was first marketed. It was found that, even though a very high melting-point asphalt had been used as the top weather-proof coating, the sheets, when piled flat and shipped to southern and even northern points, would stick together firmly. All sorts of fine powders were used as surfacing materials to attempt to eliminate the difficulty, but with little success. The research finally developed a viscose solution which could be used to coat the sheets, and this worked successfully. As you are reminded, viscose is the term applied to solutions of cellulose thiocarbonate. Heretofore, these solutions have been used largely to produce artificial silk. To prepare viscose, cellulose in the form of cotton or wood pulp is treated with caustic soda and carbon bisulphide under proper conditions to form a water-soluble compound. Viscose, when heated or treated with salt or acid solutions, decomposes to form a so-called regenerated cellulose. This regenerated cellulose has lost its fibrous structure and is clear.

By running sheets through solutions of viscose, they become coated therewith. The sheets then are dried at a temperature of about 120 deg. F., which results in the decomposition of the viscose to form cellulose hydrate. Inasmuch as the viscose on the sheets is in the form of a thin film, the regenerated cellulose hydrate produced is in the form of a thin colorless film, which completely covers the surface of the asphalt. This film prevents contact of bituminous surfaces where the sheets are piled and, as a result, the sheets do not stick together.



CUTTING THE CONTINUOUS WEB INTO INDIVIDUAL SHEETS

Another problem which has received quite a little research attention has been the fire hazard of the product. This problem has finally been solved and the product has been accepted as equal to steel sheets as a fire risk in factories by insurance companies interested in fire risks of factory buildings. This result has been obtained by using asphalt containing hexachlorinated naphthalene as the saturant for the asbestos felt. It is found that, when this procedure has been followed and the sheet is exposed to a fire, the non-combustible vapors of the chlorinated naphthalene dilute the vapors of the asphalt to such an extent that the whole will not support combustion and consequently a fire is localized in so far as the sheets are concerned.

There is in addition the problem of painting bituminous surfaces, and, as has been pointed out, its solution is not yet at hand. One very interesting development has been that of coating such surfaces with various metals to form adherent and coherent films. This may be accomplished either by depositing a thin layer of metal on the surface of the asphalt electrolytically or by spraying molten metal thereon. Although this work is very much in the developmental stage, hopes are entertained for its successful future. The product of this procedure may be varied so as to meet different chemical conditions—for example, the lead-coated product will undoubtedly give excellent service under conditions in which oxides of sulphur are the corrosive agents. The zinc-coated product is of pleasing appearance, and any of the metallized surfaces may be painted over satisfactorily with any drying-oil paint. Such products are easily handled, stored and shipped, and are admirably adapted to tropical use. Another interesting product results from the use of granulated slate or minerals of different colors as an outside surfacing material to produce different color effects.

In conclusion, emphasis is put on the fact that the future development of industries is going to be more and more along chemical lines. In fact, the large manufacturing centers are becoming large chemical laboratories. The building materials of the future must successfully withstand these widely various chemical conditions and the development of such building materials is a problem of prime importance to the chemical engineer. It is hoped therefore that this paper will serve to stimulate his interest in the general subject.

How Can Financiers Prevent Industrial Overexpansion?

The Closer Co-operation of the Engineer and the Financial Man Is Suggested as a Practical Solution to This Problem

BY IVAR J. MOLTKE-HANSEN

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THE enormous development of the world's productive capacity in many chemical and electrochemical industries spells ruin to a great many undertakings and heavy losses to banks and shareholders. Is anybody responsible for this result? Who gave the starting signal for this wild rush of capital investment in these special lines? Of course, these industries are not the only ones to suffer from an overdevelopment after the war—for instance, in shipping one sees a similar overproduction of carrying capacity.

The common reasons of these great efforts are easily established and universally familiar: the war, the call for independence of each country or group of countries in the production of important commodities and finally much easily earned money, which called for investment. Yet ought not a great deal of this investment in impossible enterprises to have been avoided? I do not now deal with imperfect construction in certain of these war-time industries, nor with the recklessness in placing contracts for construction, which led to absurd wages for manual labor in many instances. What I want to get at is the fundamental relationship among bankers, promoters of industrial schemes and the engineering fraternity.

THE OLD CRY, "LACK OF TECHNICAL CONTACT"

It appears that this all-important relationship is very casual and has been very little cultivated in most countries till now, with a few exceptions. Bankers have as a rule very little insight into the chemical and allied industries and can hardly be expected to have this special knowledge. Promoters are too often without any special practice and knowledge of actual working conditions in the industries which they propose to establish and still less in their commercial aspects. But even when such knowledge exists the interests of promoters lead to an overemphasis of the optimistic sides of a proposed undertaking. The neutral and well-informed body of college and university professors and first-rate consulting engineers is either not called in at all or only too late and with a very restricted field of action. They are perhaps requested to express themselves on the strictly technical aspect or in a case of arbitration between a company and its technical leaders or advisers and in cases of patent questions and the like.

But the evil lies, in my opinion, at the very root of things. There is insufficient control at the very beginning or even before the beginning of *new industries*. Banking concerns, interested in company promotion or in lending money to industries, ought to have a much more thorough grasp on the whole situation than is now generally the case before committing themselves to industrial schemes. I should not have raised these questions merely to criticise existing conditions if I did not think there was a remedy for the evil. The salvation lies in a competent engineering department on logical and well-defined lines in every banking concern dealing with promotion work. Here and there one may hear of advisory engineers being appointed by one or the

other bank. But comparatively seldom is the position of considerable importance.

Of all the various engineering departments of commercial banks which have come to my notice, there is one in a big Belgian bank which seems nearly perfection. I am not entitled to make its organization known publicly, but may say that it corresponds to the technical department of a big industrial enterprise. An adequate, well-equipped personnel under an experienced manager is able to cover those fields in which the bank is interested. An adequate technical library with scientific and technical periodicals and other branches of service necessary to a proper investigation of technological projects has also been established. The industrial clients of the bank are carefully watched as long as the bank takes an interest in them. The technical and financial control is serious and concerns itself with no other intention than to secure the safe development into fuller independence of the concerns in question, the degree of patronage being graded according to the needs of each case individually. The financial management of the bank is very well satisfied with the operation of its technical department, which after a short time became self-supporting through a system of modest working charges on services rendered to the various industries dependent on it.

TANGIBLE RESULTS OF A REAL SYSTEM

Such an organization secures fair treatment all around. Promoters will have confidence in submitting their propositions to such an impartial body; investors will know that an invitation to subscribe to a new company, whose working plans have been approved by his bank's technical service, offers the maximum safety.

The bank management will feel that no diversity of interests exists between the technical report of its own engineers and the policy of the bank and finally that the bank enters into no engagement with shut eyes as to what the undertaking may ultimately lead to in regard to capital outlay. The sad results in many countries of the war and post-war activity in promotion or extensions prove too well that in this field ignorance is not bliss. Any bank adopting the policy of full technical and commercial research of any industrial proposition put before it by its trained staff of experts will certainly in the end find that knowledge is power.

A conversation I had with my late friend Prof. Joseph W. Richards in September, 1921, on these questions made me believe that also in America things might be improved in this respect: the important and neglected rational relationship between the engineer and the banker. And to sum up my impressions and the experiences which have come to my knowledge: Much of the financial disaster from overproduction capacity after the war might have been avoided, had the banks and the financiers had at their disposal a well-established, technical service forming an integral part of their business outfit, somewhat on the lines indicated in the Belgian bank.

Drastic examples may be called in to witness the truth of this observation, which on reflection may seem so obvious to many as to be compared with the famous egg of Columbus. Yet it is one thing to admit the truth of a statement, another to conquer the inertia of long-established neglect and reliance on the rule-of-thumb methods. The vital need of the hour calls for more exact businesslike and scientific treatment of the problems of the right relationship among capital, industrial initiative and engineering.

The Resolution of Petroleum Emulsions

BY HAROLD V. DODD

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THE factors controlling the stability of emulsions in general have been thoroughly studied during the last 20 years, and the results of these studies were admirably presented and reviewed in some recent articles.¹ In this paper, therefore, the discussion of the theory of emulsification will be very brief.

THE TWO CLASSES OF EMULSIFYING AGENTS

A stable emulsion between two immiscible liquids is possible only in the presence of a third substance, the emulsifying agent, which collects at the interface and forms there a coherent film. There are two kinds of emulsifying agents—namely, those that are apparently soluble in one phase of the emulsion, and those that are insoluble. Investigation has shown that the apparently soluble emulsifying agents are actually colloids. The insoluble emulsifying agents are finely divided solids that have the property of collecting at the interface between the two liquids.

The only difference in the behavior of the two classes of emulsifying agents is that the colloids lower the interfacial tension, and it is generally supposed that the insoluble emulsifying agents do not. Lowering of interfacial tension undoubtedly promotes emulsification, but is not essential. The essential property of an emulsifying agent is its tendency to collect at the interface and form a coherent film, which prevents coalescence of the globules of the dispersed phase. If the emulsifying agent is water-soluble (a hydrophile colloid), or is more readily wet by water than by oil, the aqueous phase will be external; if it is oil-soluble (a hydrophobe colloid), or is more readily wet by oil, the oil phase will be external.

It has been claimed that ions adsorbed upon the globules of the dispersed phase will act as emulsifying agents, but there seems to be no satisfactory evidence that a true emulsion has ever been produced without the presence of a solid or colloidal emulsifying agent. There is no doubt, however, that the static charge on the globules of the dispersed phase, whether due to ion adsorption or to other causes that are not thoroughly understood, often increases the stability of an emulsion to a considerable extent.

THE EMULSIFYING AGENT IN PETROLEUM

All crude petroleum emulsions are of the water-in-oil type, and we, therefore, know that the emulsifying agent must be some oil-soluble colloid, or some finely divided, insoluble solid that is more readily wet by oil than by water. Crude petroleum contains heavy hydrocarbons, such as asphalt, asphaltenes, etc., which are probably present in colloidal solution and could reasonably be expected to act as emulsifying agents.

Sherrick² suggests the importance of these asphalt-like bodies in the formation of petroleum emulsions, but since not all asphalt base oils emulsify easily, he thinks these colloidal substances are not, alone, effective as emulsifying agents, but must first be adsorbed upon hydrated earthy material, which is thus changed from a water-soluble to an oil-soluble colloid. This does not seem probable, because the conditions cited by him as favorable for the formation of such a colloid are not likely to have been of wide occurrence, and also because many emulsions contain little or no earthy material.

Furthermore, such an assumption is not necessary—the nature of the solution of the asphalt-like bodies in the crude oil probably depends upon the ratio of light fractions to lubricating fractions, and consequently the tendency to emulsify should be expected to vary; as the dispersion approaches that of true solution the tendency to emulsify should be expected to decrease. In every case that has come to the writer's attention, dilution with gasoline has made the emulsion more difficult to break. This indicates that the degree of dispersion of the asphalt-like bodies is more favorable for emulsification in light fractions than in heavy.

ASPHALT IN OIL-FIELD EMULSIONS

To test the effectiveness of asphalt as an emulsifying agent, the writer prepared some emulsions of distilled water dispersed in gasoline solutions of asphalt of various concentrations. The asphalt used was a refined product sold by the Standard Oil Co. of California under the

Substances Soluble in Both Phases Are Found to Be Effective Agents for Breaking Down Crude Oil Emulsions, Providing Very Small Amounts of Acid Such as Sulphuric Are Also Introduced. The Mutually Soluble Substances, of Which Phenol Proved the Most Satisfactory of Those Tested, Conveys the Acid Through the Enveloping Oil to the Dispersed Water. It Has Also Been Found Advantageous to Use a Certain Amount of Heat During the Reaction

name of "asphaltum cement." The emulsions were prepared by placing 50 cc. of water and 100 cc. of asphalt solution in 500-cc. graduated cylinders and agitating for 2 minutes by means of a 1½-in. propeller revolving at 3,500 r.p.m. When the concentration of asphalt in gasoline was 0.05 per cent by weight, no emulsion was produced; when the concentration was 0.1 per cent, 20 cc. of water was emulsified; when the concentration was 0.2 per cent or more, all of the water was emulsified.

These emulsions settled to the bottom of the excess gasoline within a short time and formed a compact, brown mass. They stood in the laboratory for 3 weeks, and at the end of that time none of them showed any tendency to break. Their extreme stability was shown by the fact that when a 25-cc. sample was shaken with 75 cc. of clean gasoline and the mixture centrifuged for 5 minutes, the same compact emulsion, slightly lighter in color, was thrown down instead of water. This procedure was repeated several times on the same sample with no results other than some change in color. An emulsion similar in appearance and similar in reaction to this test was obtained from an oil-field emulsion by diluting with gasoline and centrifuging.

Crude petroleum is said to contain traces of saponifiable organic acids. If this is a fact, it is reasonable

¹Emulsification Symposium: *J. Ind. Eng. Chem.*, vol. 13 (1921), pp. 1008-1017, 1116-1123.

²*J. Ind. Eng. Chem.*, vol. 12 (1920), p. 133; vol. 13 (1921), p. 1010.

to expect oil-soluble soaps, which might act as emulsifying agents, but the amount of these would be so small, if present at all, that they may be neglected.

It is quite apparent that asphalt-like bodies, under certain conditions of solution, are very effective emulsifying agents. Since they are present in considerable amounts in all Western crude oil, it is safe to assume that they are responsible for the oil-field emulsions.

BREAKING EMULSIONS CHEMICALLY

There are two antagonistic forces at the interface between the phases of an emulsion—namely, (1) surface tension, which tends to cause coalescence, and (2) the coherence of the film of emulsifying agent, which tends to resist coalescence. The stability of an emulsion depends upon the relative magnitudes of these opposing forces. If the coherence of the film of emulsifying agent is so great that surface tension is unable to rupture it, the emulsion is permanent. Thus it is evident that there are two general methods by which the stability of an emulsion may be decreased—first, by an attack upon the emulsifying agent, and second, by increasing the surface tension at the interface.

Chemically, the attack upon the emulsifying agent may be made by destroying it, or by converting it into an ineffective form. The ideal method, of course, is to destroy it and thus give surface tension, however small, an unrestricted opportunity to cause coalescence, but this is frequently impossible or impracticable. To convert the emulsifying agent into an ineffective form, a substance may be added that dissolves it and thus removes it from the interface; or one that flocculates it to such an extent that a coherent film is no longer formed; or one that tends to form the reverse type of emulsion—a counter-colloid.

In most, if not all, emulsions there is an electric charge upon the globules of the dispersed phase. According to Sir Oliver Lodge¹ an electric charge on a drop causes a slight distending force which tends to diminish surface tension; this tendency is vastly increased as the drop grows smaller, because surface tension varies inversely as the simple diameter of the drop, while the electric tension varies inversely as the fourth power of the diameter; hence, when a certain minimum size is reached, the two opposing tendencies become equal and the drop behaves as if flat. Lewis² used this idea as a basis for a theory of emulsification which, while seeming to fit the facts in many ways, does not seem capable of proof.³ It is safe, however, to assume that the electric charge upon a globule of the dispersed phase of an emulsion materially reduces surface tension, and that if the charge is large (probably due to adsorbed ions of electrolytes in solution in the water) it may contribute to the stability of the emulsion to a considerable extent. In some such cases the neutralization of the electric charge results in the increase of surface tension to such an extent that the film of emulsifying agent is no longer able to prevent coalescence.

In many emulsions a marked lowering of surface tension is due to an inherent property of the emulsifying agent, and it can be increased only by destroying or modifying the latter. In view of the foregoing it becomes increasingly apparent that in order to control intelligently the breaking of an emulsion it is necessary

first to determine the nature and properties of the emulsifying agent.

PREVIOUS WORK ON PETROLEUM EMULSIONS

In the case of crude petroleum emulsions, the emulsifying agent (asphalt) cannot be destroyed. Hydrophile (water-soluble) colloids that are strongly interfacial should, however, render it ineffective, because of their tendency to form emulsions of the reverse type. Considerable success appears to have been attained with this class of compound⁴ in the mid-continental fields, but it is far from a universal remedy. The great difficulty lies in conveying the aqueous solution of the colloid through the enveloping oil to the dispersed water, which it must reach in order to be effective. As far as known, this method has not proved successful on emulsions from California fields. The latest development along this line is the "oil-soluble" hydrophile colloid.⁵ This should be more effective.

While experimenting upon an emulsion from a Texas field Sherrick⁶ found that the water globules carry a negative electric charge and that the water can be precipitated by neutralizing this charge. He also found that the efficiencies of acids in neutralizing the charge are directly proportional to their hydrogen ion concentration—thus, in order of efficiency: hydrochloric, sulphuric, acetic acids—and that other electrolytes with strongly adsorbed positive ions also neutralized the charge and precipitated the water, notably ferric chloride and ferric nitrate. He also reported that the extent to which the negative ion is adsorbed simultaneously with the positive ion is of considerable importance.

EARLY EXPERIMENTS

The first work done on petroleum emulsions by the writer was an attempt to repeat some of Sherrick's experiments, using an emulsion from the Midway-Sunset field of California. It was easy to prove that the water globules carry a negative charge. When a sample of the emulsion was put into a U-tube and a direct current of 250 volts impressed upon it by means of an electrode in each arm, the arm containing the positive electrode became black, and the one containing the negative electrode became lighter brown in color than formerly. On the positive side the negative water globules had migrated to the electrode, leaving the pure black oil against the glass; on the negative side the water globules were repelled to the glass, where their increased concentration resulted in the lighter brown color.

When the acids were tried, it was found that their order of efficiency was the reverse of that found by Sherrick, and that considerable heat and time were necessary in all cases. Sulphuric acid combined with the oil and, therefore, would not work at all. Hydrochloric acid in high concentrations caused some precipitation of water. Acetic acid precipitated the water most completely, in the least time and with the least amount of heat.

Ferric chloride and ferric nitrate solutions were merely incorporated in the emulsion. Some other salts, such as ferric sulphate and calcium chloride, caused some minor coalescence of the water globules after long heat-treatment. On the whole the action of electrolytes

¹"Modern Views of Electricity."

²*Z. Kolloid*, vol. 5 (1909), p. 91.

³Bancroft, *J. Phys. Chem.*, vol. 16 (1912), p. 210.

⁴Notably a chemical sold under the trade name of "Tret-O-Lite." This preparation was not tested in this laboratory because the manufacturers refused to send a sample for that purpose.

⁵Ayres, E. E., *J. Ind. Eng. Chem.*, vol. 13 (1921), p. 1011.

⁶*J. Ind. Eng. Chem.*, vol. 12 (1920), p. 133.

alone, on California emulsions, was not sufficient to encourage further investigation.

However, it was later found that if a substance that is soluble in both phases of the emulsion is added with the acids, the efficiencies of the latter are as found by Sherrick. The use of this class of substances as an aid in the resolution of crude petroleum emulsions is the principal subject of this paper.

SELECTION OF OIL-SOLUBLE SUBSTANCES

Since the asphalt film around the water globules behaves as if it is, to all intents and purposes, insoluble in both phases, it was decided to conduct a search for some oil-soluble substance small amounts of which would destroy, or at least greatly modify, this film and thus permit the water globules to coalesce. In the preliminary experiments it happened that of the first three tried, one was practically insoluble in water, one slightly soluble and the third soluble to a considerable extent. The results seemed to be in proportion to this solubility, and therefore the series in the following table was tried in order to determine if any such generalization could be made.

In each case 2 cc. of the substance was added to 20 cc. of emulsion containing 25.6 per cent of water by volume, in a 100-cc. centrifuge tube, and heated to 45 deg. C. Each tube was then shaken by hand for 1 minute, and then kept at a temperature of 45 deg. C. for 3 hours. After this period it was centrifuged for 5 minutes by means of an electric centrifuge, and the amount of water thrown down noted.

Chemical.....	Solubility in 100 cc. Water, Grams	Water Precipitated, cc.
Carbon tetrachloride.....	0.08	0.0
Amyl nitrite.....	1.2	0.1
Fusel oil.....	3.0	4.8
Aniline.....	3.5	5.0
Butyl and propyl alcohols (mixed).....	5.0	5.0
Ethyl acetate.....	8.6	0.5
Acetone.....	All proportions	1.5
Butyric acid.....	All proportions	6.0

The solubilities given above for amyl nitrite, fusel oil and the butyl-propyl alcohol mixture are rough determinations made in this laboratory, but are sufficiently accurate for the purpose. It is quite apparent that the effect of oil-soluble substances cannot be predicted by their solubility in water alone; other properties are also important—probably, chiefly, the extent to which they will mix with asphalt, and the presence of a strongly adsorbed positive ion. It was concluded, however, that no oil-soluble substance is likely to have a marked tendency to aid in the breaking of an emulsion unless it is also water-soluble to a considerable degree. This conclusion in regard to mutual solubility has been proved sound by the results of all experiments later performed.

ACIDIFIED MUTUALLY SOLUBLE SUBSTANCES EFFECTIVE

It will be remembered that of the acids tried upon this emulsion, acetic was decidedly the most effective—it is undoubtedly somewhat soluble in the oil. The action of butyric acid, which is miscible in all proportions with both phases, is rapid and complete. This led to the idea of conveying a readily adsorbed positive ion through the enveloping oil to the water globules by means of a mutually soluble substance. The first application of this idea was made with acidified fusel oil.

In the following tests 100 cc. of emulsion was treated

with 5 cc. of acetic acid and fusel oil in the various proportions shown in the following table. The mixtures were placed in 500-cc. graduated cylinders, agitated for 2 minutes by means of a 1½-in. propeller revolving at 3,500 r.p.m., and then heated to 45 deg. C. for 24 hours on a steam radiator. After 24 hours the condition of the emulsion in each case was noted.

Chem. Mixture 5 cc. Fusel Oil	Acid	Results
5	0	Emulsion slightly darker in color.
4	1	Green-black color; perceptible coalescence of water into globules at bottom of cylinder.
3	2	Same as above, but globules of water very much larger—up to 1/16 in. diameter.
2	3	In addition to very large globules, some water precipitated.
1	4	Practically complete precipitation of water.
0	5	Emulsion slightly darker in color.

Untreated petroleum emulsion is chocolate-brown in color. When the water globules coalesce to macroscopic size, the color changes to black. Thus a color change is an accurate indication of a change in degree of dispersion of the water.

This experiment showed that a small amount of acetic acid in the presence of a mutually soluble substance is far more effective in breaking petroleum emulsions than either chemical alone. Similar experiments, in which the actions of acetic, hydrochloric and sulphuric acids were compared, resulted in concurrence with Sherrick's conclusion that acids that ionize readily are most effective.

TESTS WITH PHENOL

A search was made among the organic compounds for mutually soluble substances, with the hope that something cheap, and effective in minute amounts, would be found. Phenol proved to be the most suitable substance encountered. The following standard manipulation was adopted for its thorough testing.

The Emulsion—The emulsion used in these tests was obtained from the General Petroleum Corporation, Taft, Calif. The gravity was 19 deg. Bé. and the emulsion contained 35 per cent of water by volume—thus each sample of 150 cc. contained 52.5 cc. water.

Sample—150 cc. of emulsion in a 500-cc. graduated cylinder.

Chemicals—As indicated in the tables of results.

Heat—50 deg. C. in a water bath for 1 hour before the addition of the chemicals and agitation, and for 2 hours after. The heat was turned off at the end of this period, but the samples were left in the water bath while it was cooling. A circular tank 2 ft. in diameter and 8 in. deep, filled with water to depth of 6 in., was used for the water bath.

Agitation—Two minutes with a 1½-in. propeller, revolving at 3,500 r.p.m., unless otherwise stated in the table.

Twenty-four Hours After Agitation—The samples were heated in the water bath to 50 deg. C. The purpose of this heating was to make the oil more fluid so that it could be handled with a pipette readily, but it also undoubtedly had some effect upon the emulsion. Then the top 50 cc. of each sample was withdrawn with a pipette, diluted with 50 cc. of gasoline, and centrifuged for 5 minutes to determine the water content of this layer. Part of the water often came down as an emulsion, therefore both free water and emulsion were recorded. (Column No. 1 in the tables which follow.) The remainder of the sample was slowly stirred with a glass rod, and the amount of free water in the bottom of the cylinder noted. (Column No. 2.) The purpose of the stirring was to cause the large globules of free water to coalesce and settle.

Constant Factor—When there was a constant factor other than those already stated, it is stated at the top of the table.

Color Change—The untreated emulsion is brown and the clean oil is black. Experience has shown that a darkening of color indicates coalescence of the water globules.

The phenol used in all the experiments was made liquid by the addition of 15 per cent of water.

TABLE I—EXPERIMENTS HAVING AS A CONSTANT FACTOR—1 CC. PHENOL

Variable Factor	1 Top 50 cc.		2 Free Water in Cylinder	Color Change
	Water cc.	Emulsion, cc.		
H ₂ SO ₄ , 4	0	0.05	55*	Black
H ₂ SO ₄ , 3	0	.05	55*	Black
H ₂ SO ₄ , 2	0	0	55*	Black
H ₂ SO ₄ , 1	trace	.2	52*	Black
H ₂ SO ₄ , 0.5	0	.18	53*	Black
H ₂ SO ₄ , 0.4	0	.15	52*	Black
H ₂ SO ₄ , 0.3	0	.1	50*	Black
H ₂ SO ₄ , 0.2	0	.05	45*	Black
H ₂ SO ₄ , 0.1	.2	2.3	0†	Black
H ₂ SO ₄ , 0.1	.5	1.3	0‡	Black

* Water acid to litmus paper.

† Water obtained by centrifuging a sample of oil from the bottom of the cylinder had a very slight alkaline reaction.

‡ Water obtained by centrifuging was very slightly acid to litmus paper.

TABLE II—EXPERIMENTS HAVING AS A CONSTANT FACTOR—0.02 CC. H₂SO₄

Variable Factor cc.	1 Top 50 cc.		2 Free Water in Cylinder cc.	Color Change
	Water, cc.	Emulsion, cc.		
Phenol, 1.0	0	0.5	50	Black
Phenol, 0.75	trace		50	Black
Phenol, 0.50	trace		5	Black
Phenol, 0.25	0	17.5	0	Very slight

TABLE III—EXPERIMENTS HAVING AS A CONSTANT FACTOR—0.5 CC. PHENOL

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
H ₂ SO ₄ , 0.2	trace		trace	Black
H ₂ SO ₄ , 0.4	trace		40	Black
H ₂ SO ₄ , 0.6	trace		48	Black
H ₂ SO ₄ , 0.8	trace		50	Black

Experiments having a constant factor—0.25 cc. phenol

H ₂ SO ₄ , 0.2	0	20.0	0	Black
H ₂ SO ₄ , 0.4	0	5.5	0	Black
H ₂ SO ₄ , 0.6	trace		15	Black
H ₂ SO ₄ , 0.8	trace		15	Black

TABLE IV—RESULTS OF TREATING SLUDGE WITH PHENOL AND ACID

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
Phenol, 0.75	0	0	5	Black
H ₂ SO ₄ , 0.3	0	0	45	Black
Phenol, 0.75	0	0	45	Black
H ₂ SO ₄ , 0.6	0	0	47	Black
Phenol, 1.0	0	0	47	Black
H ₂ SO ₄ , 0.3	0	0	50	Black
Phenol, 1.0	0	0	50	Black
H ₂ SO ₄ , 0.6	0	0	50	Black

It is quite apparent from the results tabulated in Table I that the emulsified water was alkaline and that enough acid was required to make it distinctly, but not necessarily strongly, acid.

Having determined the minimum amount of sulphuric acid that would give good results, the tests reported in Table II were made to see to what extent the amount of phenol could be cut down.

Thus the minimum amount of chemicals that could be used and still get good results was 0.75 cc. of phenol plus 0.2 cc. of sulphuric acid to 150 cc. of emulsion. This is an incomparably smaller amount than is necessary when acid alone is used, and the time and heat necessary are also much less.

The rapid increase in the amount of acid necessary to produce a separation when the amount of phenol used was cut down is shown in Table III.

The heavier oil fractions were removed from a quantity of emulsion by diluting with gasoline and centrifuging. This resulted in a "sludge" containing about the same amount of water (35 per cent) as the original emulsion, but differing from it in that the water was suspended in impure gasoline instead of in crude petroleum. Table IV shows the results obtained when some of this sludge was treated with phenol and acid in the

TABLE V—TESTS WITH KEROSENE ACID SLUDGE

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
Sludge, 5.0	trace		50	Black
Sludge, 4.0	trace		43	Black
Sludge, 3.0	trace		43	Black
Sludge, 2.0	trace		43	Black
Sludge, 1.0	trace		25	Black
Sludge, 0.5	No apparent change in emulsion.			

usual manner. It will be noted that it does not respond to treatment as readily as ordinary petroleum emulsion. This tends to substantiate the opinion expressed earlier in this paper, that the efficiency of asphalt as an emulsifying agent probably depends upon the nature of the oil in which it is dissolved.

ACID SLUDGE STUDIES

Refinery acid sludge is a complex byproduct obtained when petroleum distillates are purified with sulphuric acid. Besides acid, it is said to contain aromatic compounds and other organic substances some of which might be expected to be soluble both in oil and in water. It was therefore decided to test this sludge. Kerosene acid sludge was used.

In all cases the free water that settled out was acid to methyl orange; when only 1 cc. of sludge was used, this acidity was very slight. In all cases, except the last, the oil was tested for acidity (after the free water had settled out) and found to be acid to methyl orange. The test was made by shaking distilled water with the oil, and then centrifuging the water out and testing it with methyl orange.

By titration with a standardized solution of sodium hydroxide, 1 cc. of the sludge was found to be equivalent in acidity to 0.4 cc. of sulphuric acid. It is apparent from the results shown in Table V that something besides the acidity of the sludge is active in precipitating the water from the emulsion; an equivalent amount of sulphuric acid will not produce comparable results unless phenol is also present. This probably is due to the mutually soluble substances in the sludge. When the content of this class of compounds was increased by the addition of varying amounts of phenol, it was found, as shown in the tables to follow, that the acid sludge could be reduced to an amount roughly equivalent in acidity to the minimum effective amount of sulphuric acid.

TABLE VI—ACID SLUDGE EXPERIMENT USING VARYING PROPORTIONS OF PHENOL
Constant Factor—0.75 cc. Phenol

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
Sludge, 2.0	0	0	50*	Black†
Sludge, 1.5	trace		50*	Black†
Sludge, 1.0	trace		50*	Black†
Sludge, 0.5	trace		50*	Black†
Sludge, 0.4	trace		50*	Black†
Sludge, 0.3	trace		40*	Black†
Sludge, 0.2	trace		10‡	Black†

Constant Factor—0.50 cc. Phenol

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
Sludge, 2.0	0	0	50*	Black†
Sludge, 1.5	trace		50*	Black†
Sludge, 1.0	trace		50*	Black†
Sludge, 0.5	trace		47*	Black†

Constant Factor—0.25 cc. Phenol

Variable Factor, cc.	1 Top 50 cc.		2 Free Water in Cylinder, cc.	Color Change
	Water, cc.	Emul., cc.		
Sludge, 2.0	trace		50*	Black†
Sludge, 1.5	trace		50*	Black†
Sludge, 1.0	trace		50*	Black†
Sludge, 0.5	trace		30*	Black†

* Water was acid to methyl orange.

† Oil was acid to methyl orange.

‡ Water was neutral to methyl orange.

It was later found that all emulsions do not respond to this treatment with equal readiness. Another shipment, presumably from the same well, was found to require a higher temperature, and, when phenol and sulphuric acid were used, a considerable increase in the amounts of the reagents. It was therefore concluded that each emulsion is an individual problem from the standpoint of this method of treatment.

A THEORY OF EXPLANATION

The explanation of the breaking of petroleum emulsions by mutually soluble substances is not clear. At first sight the decrease in interfacial tension due to their presence would seem likely to promote, rather than prevent, emulsification, but this effect apparently is of small importance compared with others tending to decrease stability. When a mutually soluble substance is used alone, a comparatively large amount is necessary to have any apparent effect upon the stability of an emulsion; the results, if any, are undoubtedly due largely to the solvent effect upon the asphalt films around the water globules. When acid is also present, the amount of mutually soluble substance necessary to cause coalescence is often so small that it is not reasonable to attribute the result to solvent effect. It is entirely reasonable, however, to assume that the mutually soluble substance conveys the acid through the enveloping oil to the dispersed water; and that, having come in contact with the water, the H ion of the acid neutralizes the negative charges thereon and thus establishes conditions favorable for coalescence.

If this view is sound it is reasonable to suppose that other electrolytes with strongly adsorbed positive ions can be substituted for the acids, provided such electrolytes are soluble in the mutually soluble substance. This was not tried.

The further investigation of the mutual solubility idea was carried out with sulphur dioxide gas. The latter, being an acid gas that is soluble both in water and in some of the fractions of crude oil, should break an emulsion if enough of it could be forced to stay in solution while the emulsion is being heated. Considerable success was attained in breaking petroleum emulsions when small samples in test tubes were saturated with the gas under from 5 to 10 lb. pressure for 1 hour, and then heated to 50 deg. C. When large samples were used, the results proved unsatisfactory.

CONCLUSIONS

There are two antagonistic forces at the interface between the phases of an emulsion—namely, interfacial tension, which tends to cause coalescence, and the coherence of the film of emulsifying agent, which tends to resist coalescence. The stability of an emulsion depends upon the relative magnitudes of these opposing forces.

There are, therefore, two general methods by which the stability of an emulsion may be decreased—first, by an attack upon the emulsifying agent, and second, by increasing the surface tension at the interface.

The emulsifying agent in petroleum is probably asphalt. The coherence of the film of asphalt depends to a considerable extent upon the nature of the oil—an excess of light fractions seeming to promote the formation of a coherent film.

The dispersed water globules of a petroleum emul-

sion carry negative charges which decrease the surface tension at the interface. When these charges are neutralized, surface tension at the interface is increased to such an extent that the films of asphalt are no longer able to prevent coalescence, and the emulsion breaks.

Petroleum emulsions may be broken in this manner by the use of electrolytes having strongly adsorbed positive ions, provided the electrolytes can be conveyed through the enveloping oil to the dispersed water. Ordinarily this can be done only with extreme difficulty when electrolytes alone are used, and even then only when the latter are present in excessive amounts.

Petroleum emulsions can be broken readily by means of very small amounts of acid if a small amount of a substance that is soluble in both phases is also introduced. The mutually soluble substance conveys the acid through the enveloping oil to the dispersed water.

Any mutually soluble substance should be expected to act in this manner. Of those tested, phenol is the most satisfactory. Kerosene acid-sludge contains mutually soluble substances, but not in sufficient quantity to be very effective. When a small amount of phenol is added to kerosene acid-sludge, the mixture is more effective for breaking emulsions than phenol and acid.

A certain amount of heat is necessary when using this method.

The amount of acid necessary is very small. It is not known whether enough is left in the oil to injure pipe lines and equipment or not.

ACKNOWLEDGMENT

These experiments were carried on under the direction of Prof. Theodore J. Hoover of the department of mining and metallurgy, Stanford University, whose valuable suggestions, as well as those of Prof. S. W. Young, professor of physical chemistry, are gratefully acknowledged.

Sulphuric Acid From Ferric Sulphate

Sulphuric dioxide may be used to oxidize ferrous iron when making a leaching solution to contain both sulphuric acid and ferric iron. This solution can be used as a leaching agent for the recovery of copper from oxidized ore or sulphide ores, or a mixture of these ores. SO₂ accelerates the oxidation of ferrous iron and the percentage of SO₂ present affects the rapidity with which the ferric iron breaks down for the formation of sulphuric acid. The Bureau of Mines station at Tucson, Ariz., has found that when the concentration of the SO₂ entering or bubbling through the solution containing ferrous iron is less than $\frac{1}{2}$ of 1 per cent, the formation of ferric iron proceeds more rapidly than does the breaking down of the ferric iron to form sulphuric acid. Under these conditions, it is practical to change all of the ferrous iron to ferric iron with the formation of some sulphuric acid. As the percentage of SO₂ in the entering gas increases, more of the ferric iron is broken down, so that a concentration of SO₂ can be obtained which will effect a complete reduction of all the ferric iron to ferrous iron with production of a corresponding amount of sulphuric acid. By suitably controlling the concentration of the SO₂ in the gas applied to the operation, the proportion of ferric sulphate to sulphuric acid in the final solution may be varied according to the requirements of any particular case. The rapidity of the oxidation is directly proportional to the volume of gas. Maximum oxidation is obtained in neutral solution. Reaction is retarded in the presence of free acid.

¹Robert J. Moore, J. C. Morrell and Gustav Egloff, *Met. & Chem.*, April 15, 1918, vol. 18, p. 396. "The Solubility of Paraffins, Aromatics, Naphthalenes and Olefins in Liquid Sulphur Dioxide."

Contraction and Shrinkage During Casting*

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LITTLE information has been published relating to accurate measurements of the linear contraction of the non-ferrous casting alloys and the total contraction in volume of alloys on passing from the liquid to the solid state. In foundry practice, patterns are usually made on the basis of a general figure for linear contraction of a given class of alloys—for example, aluminum alloys, brasses or bronzes—irrespective of the alloy employed. For instance, in making light aluminum alloy castings a general figure of 0.156 in. per foot is employed as the pattern allowance, although measurements by the Bureau of Mines show that in forty alloys the range was from about 0.95 to 1.80 per cent.

When a metal or alloy is cooled from the liquid state at any temperature to the solid state at any temperature—say to room temperature—its diminution in volume is the algebraic sum of three separate contractions—namely, (1) in cooling from any temperature in the liquid state to the freezing point; (2) in passing from the liquid state at the freezing point to the solid state at the melting point; and (3) in cooling from the solid state at the melting point to any lower temperature. These three contractions in volume have been termed respectively, (1) the liquid shrinkage, (2) the solidification shrinkage, and (3) the solid shrinkage. Reliable data as to the contraction of the various metals on passing from the liquid state to the solid state are scant, but on the basis that practically every well-defined property of the elements is a function of their symbol weights, it may be deduced that the contraction in volume of the metals is a periodic function of their atomic weights.

DEFINITION OF TERMS

The liquid shrinkage may be considered to be the amount of contraction in volume of a metal or alloy in the liquid state on cooling from any temperature in the liquid state to the freezing point. The greater the temperature interval through which the metal cools—that is, the higher the initial temperature of the melt—the greater the liquid shrinkage. The liquid shrinkage of a metal or alloy, therefore, is not a definite numerical value; but it varies with the temperature interval of cooling. Thus the weight of metal that can be poured into a mold at a higher temperature is less than at a lower temperature.

The solidification shrinkage may be defined as the contraction in volume of a metal or alloy on passing from the liquid state at the freezing point to the solid state at the melting point. Where an alloy solidifies over a freezing range, the solidification shrinkage is the contraction in volume which occurs from the beginning to the end of freezing. The actual amount of the solidification shrinkage varies considerably for different metals and alloys, and it may be markedly affected by the presence of impurities. So far as is known, bismuth and silicon are the only metals that expand on solidification, but a number of alloys expand; and some show expansions on cooling from liquid to solid, although the total volume change is a decrease.

The solid shrinkage is the contraction in volume of a metal or alloy on cooling from the solid state at the melting point to any lower temperature—usually the ordinary temperature—and it may be determined over any solid temperature range by experimental measurements or by calculation from the formula for expansivity. Ordinarily, in foundry practice, the solid shrinkage may be regarded as the contraction in volume on cooling from solid metal at the melting point to about room temperature. The thermal expansivity is the reciprocal of the solid linear contraction.

The linear contraction of a metal or alloy is the diminution of length that takes place in a casting on cooling in a mold. The terms linear contraction and pattern maker's shrinkage are synonymous. Turner states that the shrinkage may be defined as the difference between the length of a casting and that of the pattern from which it was produced—that is, it is the difference in volume between the fluid metal in the mold and the resultant casting at the ordinary temperature. Shrinkage in this sense, therefore, does not take into account the various stages of contraction, arrest or expansion which may occur in an alloy; but represents the final volume change. In experimental measurements, the linear contraction may be most readily determined by measuring the diminution in length of a bar cast from a pattern of definite length. It may be expressed in percentage diminution in length, in inch per foot, or in terms of the patternmaker's shrinkage scale.

PATTERNMAKER'S SHRINKAGE

In pattern practice for light aluminum alloy castings, the usual allowance for the shrinkage is $\frac{1}{8}$ in. per foot (0.156 in., or 1.30 per cent); and if a casting is to be 1 ft. long, then the pattern is made 1 ft. and $\frac{1}{8}$ in. in length. According to Keep (and his version of the matter is accepted also by Turner and others), the general understanding is that the shrinkage of a casting is the difference in length (or any other linear dimension) between the casting and the pattern from which it was made; or rather between it and the mold in which it was cast. Thus, the general figure for the shrinkage of gray cast iron is $\frac{1}{8}$ in. per foot, and the pattern maker, in taking measurements for the different dimensions of a pattern, uses a "shrink rule" which is $\frac{1}{8}$ in. longer than the standard foot-rule which is used to measure the castings.

West, however, calls "shrinkage" the decrease in volume in the liquid state, which requires feeding in casting practice and applies the term "contraction" to the decrease in volume which takes place after solidification. Also, according to McWilliam and Longmuir, "technically, 'shrinkage' refers to the gradual lessening in volume of the fluid metal as it approaches the solidification point at which 'shrinkage' ceases and contraction commences, the latter being understood to refer to the lessening in length or in volume of the solid metal." Hailstone states that "liquid contraction" is the local contraction which takes place in the heavy part of a casting when the outside skin of that casting has solidified. He states also that "solid contraction" is the natural contraction which metals undergo when passing from the hot to the cold condition; solid contraction is also known as shrinkage. The arbitrary terminology applied by West and others to contraction in the liquid and solid states seems to be based on nothing rational, and the writer prefers the terminology of Keep and Turner, which is technically correct.

*Extracted from "Reports of Investigations," Serial 2410, November, 1922.

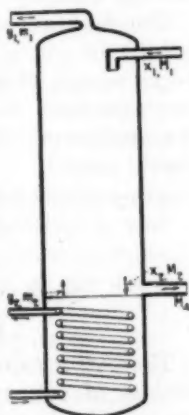
What Happens at the Lower End of the Rectifying Column

Continuing the Discussion of the Rectification of Binary Mixtures—Analysis of an Actual Rectifier With Trays—Number of Trays Necessary in Any Given Case*

BY C. C. VAN NUYS

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IN THE FOREGOING discussion we have assumed that the compositions of liquid and vapor in contact both at the top and at the bottom of the column may be those for phase equilibrium, although the equations we have written take no account of, and must be satisfied independently of, phase relations. For example, these equations hold whether y_1 is the composition of the vapor having phase equilibrium with a liquid of composition x_1 , or whether y_1 is greater than for phase equilibrium with a liquid of composition x_1 . In the actual operation of a rectification column, it is often impossible or impracticable to cause the liquid and vapor in contact at the top or at the bottom to be in phase equilibrium. In many cases, particularly in air separation processes, the vapor m_1 is derived from the evaporation, in a vaporizing compartment at the bottom of the column, of all or a part of the liquids descending therein. For example, all this liquid may be evaporated and a portion of the resulting vapor drawn off as the lower end product while the remainder of the vapor is caused to ascend in the columns as in the figure.



In this case, since the only fluid entering the pool at the bottom is a liquid of composition x_1 and the only fluid leaving it is a vapor of composition y_1 , we must have, if conditions are stable, $x_1 = y_1$, and this will be the composition of our lower end product, the mass of which is $m_1 = M_1 - m_2$.

If, however, only that portion of the descending liquid be evaporated which is utilized as vapor ascending in the column, the remainder of the liquid which drains into the pool being drawn therefrom to constitute our lower end product as shown in the figure, then x_1 and y_1 no longer need approach equality.

Let the mass of liquid drawn off from the pool and constituting our lower end product be M_1 and its composition x_1 . Then if L_1 and L_2 denote the latent heat functions introduced above, i.e., if

$$L_1 = J_1 - I_1 + (J_2 - J_1) \frac{x_1 - y_1}{y_1 - y_2}$$

and

$$L_2 = J_2 - I_2 + (J_3 - J_2) \frac{x_2 - y_2}{y_2 - y_3}$$

which, for a mixture whose latent heat follows the proportionality relation discussed above, become

$$\begin{cases} L_1 = L_B x_1 + L_A (1 - x_1) \\ L_2 = L_B x_2 + L_A (1 - x_2) \end{cases}$$

our system of equations for the whole apparatus is as follows:

$$\begin{aligned} M_1 + M_2 &= m_1 + M_2 \\ x_1 M_1 + y_1 m_2 &= y_1 m_1 + x_2 M_2 \\ L_1 M_1 &= L_2 M_2 \\ M_1 &= m_1 + M_1 \\ x_1 M_1 &= y_1 m_1 + x_2 M_2 \end{aligned}$$

This system of five equations is homogeneous in the five (M, m) 's, and by successive elimination a single equation may be obtained not containing any (M, m) . This relation is

$$\frac{x_1 - y_1}{x_1 - y_2} = \frac{L_2}{L_1} \frac{x_2 - y_2}{x_1 - y_1}$$

In this equation we may, for example, regard x_1 as stipulated and assume y_1 as the composition of the vapor having phase equilibrium with the liquid x_1 . Then, if in addition, we stipulate x_2 and M_2 , this fixes x_1 , y_1 , x_2 , M_2 , and m_2 , since two equations may be written between these six variables. The above equation then gives x_1 in terms of y_1 and the fixed quantities x_2 , y_2 , x_1 .

If, now, the pool of liquid from which the vapor m_2 arises be assumed to be homogeneous throughout and of composition x_2 , then y_2 will be the composition of a vapor having phase equilibrium with the liquid x_2 , and is therefore fixed and then the above equation fixes the value of x_1 . In any case, the value of y_1 will depend upon the conditions prevailing during the evaporation from the pool and is therefore fixed, and thus x_1 may be considered as determined by the above equation. For example, assume we are dealing with a mixture of oxygen and nitrogen and take $x_1 = 0.21$, $y_1 = 0.06$, $x_2 = 0.90$, then if we take y_2 as the vapor in phase equilibrium with the liquid x_2 , we obtain from Baly's curves (*Phil. Mag.*, vol. 49, pp. 517-529, June, 1900), $y_2 = 0.76$, from which, assuming proportionality latent heats, $x_2 = 0.788$.

Since $x_1 > x_2$, it is evident that with the arrangement shown in the last figure, x_1 and y_1 cannot have the relation for phase equilibrium. This relation is approached, however, as the mass m_2 is made smaller relative to a fixed M_2 , with x_1 and y_1 constant. Under these conditions, however, x_1 decreases, although y_1 may remain at the value corresponding to phase equilibrium with x_1 . x_2 and y_2 could attain the relation for phase equilibrium only if $m_2 = 0$, in which case $x_1 = x_2 = x_1$.

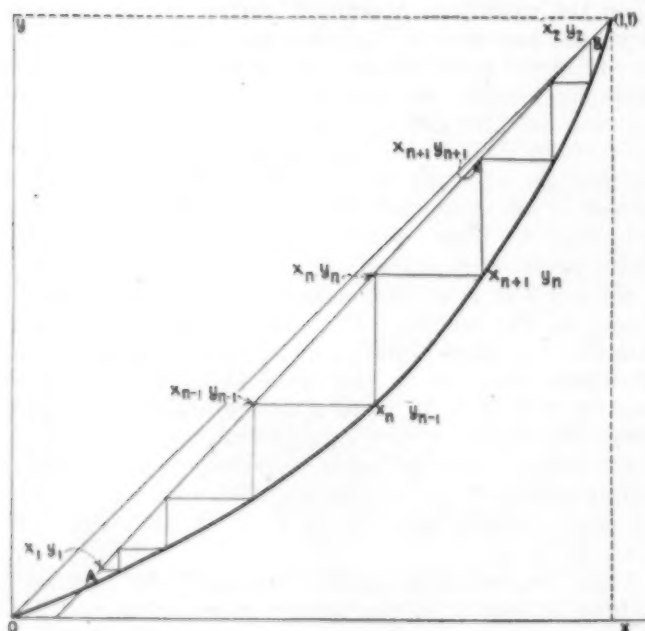
These two examples exhibit the conditions necessary to take account of at the bottom of an actual rectifier. Similar considerations will make evident the conditions existing at the top level of the rectifier, in any given case.

*The first article of this series was published in *Chem. & Met.*, vol. 28, No. 5, Jan. 31, 1923.

The problem, just considered, as to the actual conditions at the bottom of a rectifier has an intimate connection with that of the conditions existing in a rectifier containing a finite number of so-called "trays," or liquid reservoirs such as commonly employed. In all the above theory we have assumed perfect contact at every level between descending liquid and ascending vapor, and for perfect rectification we assumed that at the top and also at the bottom the liquid and vapor in contact were in phase equilibrium, although the equations we have written must be satisfied independently of phase relations. In a rectifier, however, containing a finite number of trays, there are certain limitations that must be taken account of.

Consider a rectifier as shown in the diagram where the only liquid entering it is admitted at the top, our usual notation being employed except that neither (x_1, y_1) nor (x_n, y_n) are necessarily liquid-vapor compositions for phase equilibrium. Consider the n th tray from the top, the vapor entering it from below being m_n , composition y_n , and the liquid leaving it being M_n , composition x_n , with similar notation for the trays above and below as shown. Now if the liquid on this tray be kept thoroughly homogeneous by agitation and if the vapor, m_n , be brought into thorough contact with it, the composition of this liquid on the tray will be the composition x_n of the overflow, while the composition y_{n-1} of the vapor leaving it will be that for phase equilibrium with the liquid from which it rises. That is, for an ideally perfect "tray," y_{n-1} and x_n should have the relation for phase equilibrium. The compositions x_n and y_n , moreover, have the relation obtained above for the compositions of liquid and vapor at the same level in a simple adiabatic rectifier. In the most general case, this relation is:

$$\frac{(J_n - I_n)(x_n - x_1) + (I_n - I_1)(x_n - y_n)}{(J_n - I_n)(y_n - y_1) + (J_1 - I_1)(x_n - y_n)} = \frac{(J_2 - I_2)(x_2 - x_1) + (I_2 - I_1)(x_2 - y_2)}{(J_2 - I_2)(y_2 - y_1) + (J_2 - I_2)(x_2 - y_2)}$$



With specified values of the end compositions, x_1, y_1, x_n, y_n , the above equation, with x_n, y_n considered as variables, determines a plain curve connecting the two points (x_1, y_1) and (x_n, y_n) on the x, y diagram. The values of I_n and J_n at the various points (x_n, y_n) would be determined by the physical properties of the mixture dealt with.

For a mixture whose latent heats at constant pressure follows the proportionality relation discussed above, the equation just written is somewhat simplified, as we have seen, while for equal latent heats of the pure constituents it is the equation of a straight line connecting the points (x_1, y_1) and (x_n, y_n) .

In the diagram let 0-(1,1) represent the equilibrium curve, while AB represents the locus of the above equation between x_n and y_n . Then with the values of the end compositions, (x_1, y_1) and (x_n, y_n) as shown, it may be seen that the minimum possible number of trays is equal to the number of segments into which the line AB has been divided by the various points (x_n, y_n) . . .

The diagram shows that if either of the two points (x_1, y_1) or (x_n, y_n) is located on the equilibrium curve, 0-(1,1)—i.e., if at either end we assume phase equilibrium between descending liquid and ascending vapor, the number of "trays" required will be infinite, as we should expect.

Continuation of this series of articles will be published in a subsequent issue.

Suggested Research Problems in Electrochemistry

The American Electrochemical Society has issued a booklet of suggestions to authors, embodying some of the standards set by the society for papers presented before its meetings.

The following list of research problems is suggested as fruitful subjects for future papers:

- Electrolytic Deposition of Brasses and Bronzes.
- Hydrogen Potential Measurements of Aqueous Electrolytes.
- Electrochemistry of Concentrated Solutions.
- Electrolytic Production of Organic Compounds.
- New Uses for Chlorine and Caustic.
- Electrolytic Production of Lithium Hydrate.
- Studies of the Properties of the Alkaline Earth Alloys.
- Effect of Impurities in the Electrolysis of Fused Magnesium Salts.
- The Electrochemistry of Gaseous Conduction.
- Electrical Conductivity of Metals and Alloys Above Melting Point.
- Stability of the Metal Carbides at Elevated Temperatures.
- Revised Melting Point Determination of Refractory Oxides, Pure and Commercial.
- Stability of the Metal Silicides at Elevated Temperatures.
- Energy Losses in Electric Furnaces.
- Gaseous Reduction of Metal Compounds.
- Equilibria Studies in Electric Steel Furnaces.
- Putties and Cements Used in Electrochemical Industries.
- Electrical Porcelain.
- Dielectric Constants of Mineral Oils.
- Dielectric Constant vs. Composition of Glasses.
- Dissociation of Compounds in the Beck Arc.
- New Uses for Iodine; the Electrolytic Production of Iodine Compounds.
- The Electrolytic Corrosion of Alloys.
- The Fixation of Atmospheric Nitrogen.
- Electrochemical Problems Relating to the Soil.
- The Electric Stimulation of Plant Growth.
- Electrolytic Dissociation in Non-Aqueous Electrolytes.
- Catalytic Phenomena in Electrolytic Reactions.
- Physical Properties of Elements and Materials at Electric Arc Temperatures.
- The Occlusion of Gases by Metals at Electric Furnace Temperatures.
- Electric Conductivity of Flames.

Properties of Wood in Paper Making*

The Effect of Physical and Chemical Properties of the Wood on Economy and Quality, Particularly in the Sulphite Process

BY BJARNE JOHNSEN and H. N. LEE

THE suitability of any kind of wood for paper making is determined by its physical and chemical characteristics. Very resinous woods, like the pines, are not suitable for the sulphite process, but make an excellent raw material for the sulphate or kraft process. Soda pulp from poplar is used in certain papers such as book papers on account of the short, bulky fiber, but cannot be used for papers where strength is required. It is not the intention of this paper to discuss the value of the various species of wood for all different pulping processes and for the different grades of paper. This discussion will deal chiefly with the most important pulpwoods, spruce and balsam, and their use in the sulphite process, which is by far the most important chemical process. However, much of the data given may be equally well applied to other woods and other processes.

In discussing the properties of wood for paper making there are two chief considerations—economy and quality. Wood is ordinarily purchased on the cord basis and the consumption of wood is recorded on the cord basis. It is customary to express the yield of pulp in terms of cords used per ton of pulp, but while the enormous variations in this figure in different mills may, to a great extent, be accounted for in the different methods used in the manufacturing process, it is not possible so to explain the great variations which are experienced in any one mill. These variations can be explained only when the actual value of the cord based on the physical and chemical properties of the wood are known.

MEASUREMENT OF CORD WOOD

Considering first the physical properties, it is known that a very large variation can exist in the amount of solid wood in the cord. According to Sterns¹, the theoretical solid content of the cord is always the same pro-

TABLE I—CUBIC FEET PER CORD

Length	Graves ²		Winslow and Thalen ³			
	Over 5.5 In. Diameter at Small End	2.5 to 5.5 In. Diameter at Small End	Mixed	Straight	Crooked	Knotty
30 in.	90.5	83.9	87.2			
4 ft.	88.9	82.4	85.7	92	82	74
8 ft.	83.8	77.2	80.5	82	75	50

vided the logs are all of the same diameter. In this case the theoretical solid content is 90.69 per cent (116.1 cu.ft.). If the logs differ in diameter, the solid content will be greater and will increase as the ratio of the largest diameter to the smallest increases. However, in actual measurements he found no cords contained over 80 per cent (102.4 cu.ft.) solid wood. He also found that the average solid volume per cord of 32-in. wood, based on careful volumetric measurement of 34

*A paper read at the annual meeting of the Technical Section of the Canadian Pulp and Paper Association, Montreal, Jan. 24 to 25, 1923.

¹R. W. Sterns (unpublished data), Abitibi Power & Paper Co., Canada.

²H. S. Graves, "Forest Mensuration" John Wiley & Sons, N. Y.

³Winslow & Thalen, "The Purchase of Pulpwood," *Paper*, Oct. 4, 1916.

TABLE II—SOLID CONTENT OF WOODS FROM MINNESOTA AND QUEBEC

	Average		Maximum		Minimum	
	Que.	Minn.	Que.	Minn.	Que.	Minn.
Number of logs per cord.....	67	115	102	156	36	86
Average diameter inches, per cord.....	7.31	5.67	10.56	6.50	5.96	4.95
Cubic feet solid material per cord	88.58	85.68	99.52	91.72	69.79	77.82

cords, logs from 4 to 16 in. diameter, to be, before barking, 93.97 cu.ft., after barking 83.36 cu.ft.

Our own measurements on two very different kinds of wood, one coming from northeastern Quebec and the other from Minnesota, based on 32 cords of each class of wood, are given in Table II.

The Quebec wood was peeled, the Minnesota wood not peeled; therefore the actual wood in the latter was about 12.5 per cent less, or an average of about 75 cu.ft. per cord. The greatest variation in the amount of solid wood was due to poor packing, which in turn was frequently due to crooked or poorly trimmed logs. The figures appear to show conclusively that wood of larger average diameter, which means a mixture of small, medium and large diameters, results in more actual solid wood per cord than wood of small average diameter.

In most cases investigators have found that the larger the average diameter the greater the solid content, but Sterns found just the reverse. He believes the discrepancy may be explained by the fact that he measured 32-in. wood, while the others, in general, measured 4-ft. or 8-ft. wood. It is certainly true that the effect of crookedness of logs is greater in long logs than in short ones and it is possible that in very short logs the effect of crookedness might be comparatively small. Moreover, large diameter logs are more likely to be straight than are those of small diameter.

It has been shown in the foregoing that the actual value of a cord of wood for production of pulp, or in other words the solid wood in a cord, may be influenced by several factors and may vary considerably. To secure reliable figures from which to determine yield, as well as to handle the purchase of wood in the most efficient manner, it is quite apparent that accurate measurement of the wood is necessary.

DENSITY AND RATE OF GROWTH

The value of a given volume of solid wood for pulp is determined by the dry weight of the wood. This is dependent on the density of the wood. This varies not only with the species but also within the same species according to the conditions of growth.

Our investigations show in balsam as well as in spruce, and the same may probably be applied to other coniferous woods, that slow growth wood is more dense than rapid growth wood. The figures for logs 6 in. in diameter are given in Table III.

Moreover, as is shown in Table IV by Kress, Wells and Edwards⁴, there is considerable variation in the average density of different species of wood.

Results of tests by the authors are given in Table V.

From these data it is apparent that spruce has, on the average, 15 to 20 per cent greater density than balsam fir. Here again, as in the case of cord wood measure, are opportunities for large variations in the possible yields from cords of wood composed of more than one species or even composed of the same species of different rates of growths.

⁴Kress, Wells and Edwards, "The Suitability of Various Species of American Woods for Pulp and Paper Production," *Paper*, vol. 24, pp. 914-22, 1919.

TABLE III—EFFECT OF RATE OF GROWTH ON DENSITY

	Rings, Per In.	Weight, Cu.Ft. Dry Green Wood
Quebec spruce.....	18.5	27.6
Minnesota spruce.....	4.5	20.2
Quebec balsam.....	17.4	28.0
Minnesota balsam.....	5.7	22.4
	19.7	27.2
	4.3	18.7
	10.3	22.6
	6.4	17.8

TABLE IV—DENSITY OF DIFFERENT WOODS

	Average Weight Of 1 Cu.Ft. of Dry Green Wood
Black spruce (<i>Picea mariana</i>).....	23
White spruce (<i>Picea canadensis</i>).....	24
Balsam fir (<i>Abies balsamea</i>).....	21
Hemlock (<i>Tsuga canadensis</i>).....	24
Jack pine (<i>Pinus divaricata</i>).....	24
Aspen (<i>Populus tremuloides</i>).....	23

TABLE V—RATE OF GROWTH AND DENSITY OF CANADIAN WOODS

	Average Weight Of 1 Cu.Ft. of Dry Green Wood	Rings per In.
N. E. Quebec spruce.....	25.2	12.8
S. W. Ontario spruce.....	25.6	11.5
N. E. Quebec balsam.....	20.8	9.1
S. W. Ontario balsam.....	20.4	8.2

CHEMICAL COMPOSITION

Another factor which influences the possible yield, even when the foregoing factors are eliminated, is the chemical composition of the wood. The most important characteristic is the cellulose content. The data on this subject from different sources are not always comparable, because the various investigators have not used the same methods in making their determinations. The relative cellulose content of certain kinds of wood, based on a comparatively small number of tests is given by Johnsen and Hovey⁵ in Table VI.

TABLE VI—CELLULOSE CALCULATED AS PER CENT OF OVEN DRY WOOD

White spruce.....	56.48
Black spruce.....	50.64
Red spruce.....	52.95
Balsam fir.....	51.60
Jack pine.....	49.24
Hemlock.....	48.70
Aspen.....	57.52

Even within the same species it has been shown that the cellulose content varies. Johnsen and Hovey found in balsam fir that rapid growth (low density) wood contained 50.35 per cent cellulose, while slow growth (high density) wood contained 52.85 per cent cellulose. Thorbjornson⁶ gives the following figures for Swedish spruce, determined from different parts of the same log:

Specific Gravity	Per Cent Cellulose
0.382	53.4
0.425	57.3
0.446	58.5

As far as the two most important pulpwoods—spruce and balsam fir—are concerned it is safe to say that spruce has a slightly higher cellulose content than balsam fir. According to these data the yield which may be expected from a given volume of solid wood will be greater with woods of high density for two reasons, (1) the greater actual weight of wood substance, (2) the somewhat greater cellulose content by weight.

⁵Johnsen and Hovey, "The Estimation of Cellulose in Wood," *Pulp and Paper Magazine*, Jan. 31, 1918.

⁶B. Thorbjornson, "Nagra synpunkter beträffande sulfittökning" (Some Observations Regarding Sulphite Cooking), *Svensk Pap. Tid.*, p. 196, 1922.

The influence of the cellulose content on yield is much more marked when wood of different degrees of soundness are compared. It has been found by Acree⁷ that the cellulose content may be decreased by as much as 28 per cent. Similar results have been obtained by J. L. Parsons⁸. While in general decay decreases the cellulose content, Parsons found that decay caused by *Trametes pini* Brot. resulted in an increase in cellulose content of 15 per cent with a decrease in lignin of 30 per cent.

Another serious result of decay is a decrease in the density of the wood. Sutermeister⁹ found spruce wood which was thoroughly affected by rot but which was still quite hard and firm weighed less than 18 lb. per cubic foot of dry wood, while sound spruce weighed more than 22 lb.

RELATION TO THE MANUFACTURING PROCESS

Factors thus far considered have a bearing upon the value of the cord, particularly with regard to economy. In the following, the importance which knowledge of these factors and other factors have in the manufacturing process and on the final product will be discussed.

It is obvious that the variations in the solid content of the cord, due to the conditions of piling of wood, dimensions of logs, crookedness, and trimming, have a very great effect on the cost of production. However, these variations are eliminated as soon as the wood is in form of chips and therefore do not directly affect the capacity of the mill or the quality of the product.

Knowledge of the density of the wood is of much greater importance because it directly affects the yield and, as a result, the economy in several ways:

- (1) Dense wood gives a greater weight of wood per cord.
- (2) Dense wood gives a slightly higher cellulose content per unit of weight.
- (3) Dense wood, consequently, increases the digester capacity, which allows (a) a longer cooking time at lower temperature, which results in (b) increased yield and a better quality of product.

These points are illustrated by the results given in Table VII obtained by experimental cooks on a semi-commercial scale.

TABLE VII—SEMI-WORKS EXPERIMENTAL COOKS

	Balsam	Spruce
Weight of absolutely dry chips from cord of peeled wood, lb.....	2,036	2,580
Weight of chips in digester, absolutely dry, lb.....	268	323
Bleach consumption, per cent.....	17.2	15.5
Yield of bleached pulp, per cent dry wood used.....	42.79	43.65
Yield bleached pulp for equal volume digester charges, lb.....	115	141
Absolutely dry pulp per cord peeled wood, lb.....	871	1,126

TABLE VIII—EXPERIMENTAL PLANT COOKS

	Month A	Month B
Weight cu.ft. wet chips when absolutely dry, lb.....	15	8.64
Absolutely dry pulp, per cu.ft. digester space, lb.....	3.56	3.91
Yield absolutely dry pulp, per cent of dry wood.....	43.7	45.2
Screenings (dry), per cent of total pulp.....	3.00	2.03
Cooking time, hours.....	12	12.5
Bleach consumption, per cent.....	12.7	12.0
Slowness of unbleached pulp.....	91.0	27.1
Strength of unbleached pulp.....	92	93

Actual mill data, using two different classes of wood (average figures per month) are given in Table VIII.

These experimental and mill data show how the density of the wood affects the value of a cord and the capacity of the cooking equipment.

⁷S. F. Acree, "Destruction of Wood and Pulp by Fungi and Bacteria," *Pulp and Paper Magazine*, July, 17, 1918.

⁸J. L. Parsons, unpublished data, Hammermill Paper Co., U. S. A.

⁹E. Sutermeister, "The Use of Rotten and Stained Wood for Making Sulphite Pulp," *Pulp and Paper Magazine*, June 22, 1922.

Another factor which affects the digester capacity is the moisture content of the chips. The higher the moisture content of the chips the heavier the chips will be and consequently the better will the chips pack in the digester. Thorbjornson⁸ has shown that by using chips with an average moisture content of about 20 per cent in place of chips with a moisture content of about 40 per cent the capacity of the digester is reduced 9.5 per cent.

EFFECT OF DECAY ON YIELD

It has already been stated that the variation in cellulose content with sound wood is not great, but when rotten wood is used the cellulose content becomes a very important factor. The yield by weight, based on a number of experimental cooks, with the soda process, is shown by Sutermeister⁹ to be about 30 per cent for rotten poplar wood as compared with about 41 per cent for sound poplar. For birch an even greater reduction in yield was found. Sutermeister⁹, using the sulphite process with spruce wood, shows that the yield by weight is higher with rotten wood than with sound wood, but his conclusions do not seem entirely justified when it is considered that the two resulting pulps were not cooked down to anywhere near the same degree of purity; the sound wood yielding a pulp with only 0.6 per cent screenings and requiring only 17 per cent bleach, while the pulp resulting from the rotten wood had 6.6 per cent screenings and required over 30 per cent bleach. There is no reason to believe that decayed wood should give a higher yield by weight than sound wood, except in cases where the fungus has caused an increase in the cellulose content, as referred to in the case of *Trametes pini Brot*. This shows how necessary it is in investigations of this kind to specify the kind of fungus which has caused the decay of the wood, and also to compare resulting pulps on the basis of the same degree of purity. All of our experimental and mill data have shown a decided decrease in yield by weight when rotten wood is used. Also Bates¹⁰ found a reduction in yield by weight in large-scale experiments.

Large mechanical losses will occur if wood is decayed. Kress¹¹ gives the following figures for loss in chipping:

	Per Cent Loss in Screening 1-in. Chips
Nearly sound white spruce.....	5.62
Infected white spruce.....	13.22
Infected white spruce.....	15.60
Badly rotted white spruce.....	17.02

If wood is decayed, and especially if it is saprotten, a considerable loss also occurs in barking.

EFFECT OF DECAY ON QUALITY

The effect of decayed wood upon the quality of the pulp is not clearly evident in Sutermeister's and Bates' reports. According to Bates there is no reduction in the strength of the pulp, but his tests were made on unbeaten pulp and the difference would hardly show up at this stage, particularly when the wood is only partly decayed. Sutermeister⁹ found a decided decrease in strength of pulp in the case of the rotten wood cooked by the sulphite process. With the soda process he found an increase in the strength of pulp from partly decayed birch wood, after beating in a pebble mill, while he

found it impossible to make sheets of beaten soda pulp obtained from very rotten wood. Our own tests show that decayed wood has a decided influence on the beating quality as well as on the strength of the resulting pulp. Pulp obtained from rotten wood hydrates more rapidly when beaten, and with the hydration the strength increases. However, the maximum strength of the pulp is reached at an earlier stage in the beating process, after which point the strength decreases rapidly.

Such has been found to be the case, not only in experimental tests, but also in ordinary mill experience. Monthly figures from mill operation show that when a large percentage of wood was used which had been stored for 2 or 3 years and therefore was more or less affected by fungus, the strength of the pulp was considerably lower and the slowness considerably higher than when comparatively new, sound wood which came from the same locality was used. This was the case in spite of the fact that the cooking process was adjusted so as to protect the fiber of the more or less decayed wood as much as possible.

The deleterious effect of decayed wood used in the ground-wood process has been thoroughly investigated and described by Kress, Humphrey and Richards¹², and Bates¹³.

SEASONING

With a raw material which may be stored for a long period before it is used in the manufacturing process, it is of interest to know what effect seasoning has upon its value. It is evident that if wood is stored so that it will deteriorate from decay its value will gradually decrease. If, however, wood is stored under proper conditions, unfavorable for the growth of fungi and so that the wood may dry out, its value for pulp will increase. As Schwalbe¹⁴ has stated, green wood, because it is less resistant to the cooking process, gives a lower yield than seasoned wood, but he has found it possible to increase the yield from green wood materially by giving it a milder treatment. It has also been found in mill operation that seasoned wood gives a higher yield and a stronger fiber than green wood. During the period of storage the moisture content of the wood decreases, which is an advantage, since the moisture in the chips results in a direct dilution of the cooking liquor. However, if the wood is too dry, the penetration of the acid is much slower and more time is required to bring the digester up to the desired temperature and pressure, necessitating either a longer total cooking time or a higher temperature. Schwalbe found that the penetration period of very dry wood could be materially decreased by pretreating the chips with steam or with waste liquor.

Another objection to the use of green wood is the difficulty which is experienced in the manufacturing process due to pitch. It is generally known that the troublesome pitch-forming substances in the wood decrease during storage.

The most important of the factors which influence the consumption of wood per ton of pulp or the yield of pulp per cord, the density and soundness, are also the factors which influence the quality the most. In most cases the low-density wood and the infected wood

⁸E. Sutermeister, "Decay of Pulp Wood and Its Effect in the Soda Process," *Pulp and Paper Magazine*, July 14, 1921.

⁹J. S. Bates, "Sulphite Tests of Average Wood, Infected Wood and Chipper Sawdust," *Pulp and Paper Magazine*, June 9, 1921.

¹⁰O. Kress, "Progress in the Study of Wood and Wood Pulp Infection and Decay," *Paper Industry*, January, 1921.

¹¹Kress, Humphrey and Richards, "Some Observations of the Deterioration of Wood and Wood Pulps," *Paper Industry*, October, 1919.

¹²J. S. Bates, Grinding Tests of Average, Infected and Sound Pulpwood," *Pulp and Paper Magazine*, June 30, 1921.

¹³C. G. Schwalbe "Holzzellstoffkochung, insbesondere die Sulfite-zellstoffkochung," (Pulp Cooking, with Special Reference to Sulphite), *Zellstoff u. Papier*, April 1, 1921.

are cooked in mixture with sound wood of high density and the cooking process is adjusted to the sound wood. All the undesirable effects of low-density wood and decayed wood are therefore experienced—low yield, low strength and high slowness. If, however, the wood could be sorted according to its qualities, soundness, density, seasoning, etc., it would be possible to adjust the cooking process to some extent for the various grades. To maintain the production of the mill with low-density wood and with decayed wood the cooking time must be shortened by using a higher temperature. With this kind of wood high temperatures should be avoided.

It is, in many cases, possible to do so by shortening the penetration period of the cooking process, because wood of low density and decayed wood are more rapidly penetrated by the acid. A few experiments were made in order to determine how the penetration is affected by these factors. The results, which were obtained by placing disks of wood in a small digester with cooking acid of 6.18 per cent total SO_2 and 1.03 per cent combined SO_2 , and bringing the temperature gradually up to 100 deg. C. in 2½ hours, keeping the temperature at this point for ½ hour, give an indication of the comparative penetrability.

TABLE IX—PENETRATION RATIO BASED ON SLOW GROWTH SPRUCE EQUAL TO 100

	Rings Per In.	Wt. Per Cu.Ft.	Penetration Ratio
Slow spruce	28	28.6	100
Rapid spruce	9	23.2	180
Slow balsam	38	22.2	215
Rapid balsam	7	18.6	350
Spruce partly decayed by <i>Len. Mes sapicris</i>	..	22.0	900
Spruce badly decayed by <i>Trametes pini</i>	..	14.0	1,500

The question of proper methods of storing pulpwood has been often discussed. It will only be mentioned here that best seasoning conditions allowing a minimum amount of decay are secured when logs are peeled or barked and then stored in such a way that good circulation of air is always maintained throughout the piles.

It has been attempted in this discussion to point out some of the important factors which influence the economy and quality in the production of pulp and paper from wood, with the object of drawing more attention to this most important raw material. It is hoped that the pointing out of the factors which so greatly influence yield and quality will result in the establishment of methods of measuring and testing wood which will be of great value in the intelligent purchase and handling of wood and which will explain variations in yield and quality hitherto not full accounted for.

Attendance at Engineering Schools

The United States Bureau of Education has obtained the following figures for attendance at engineering schools for the current year. A few of the smaller engineering schools have not reported:

Attendance for 1921-22:		
Freshmen and sophomores	32,178	
Juniors	11,446	
Seniors	8,520	
Corresponding enrollment for 1922-23:		
Freshmen and sophomores	29,952	
Juniors	10,383	
Seniors	9,571	
Total for 1921-22	52,144	
Total for 1922-23	49,906	
Decrease for the current year	2,238	

It seems that the engineering schools have reached their maximum attendance for the present. This attendance is probably limited by the schools' facilities.

Manufacture of Soap in 1921

The Department of Commerce announces that reports made to the Bureau of Census show that production by establishments engaged primarily in the manufacture of soap amounted to \$240,116,000 in 1921, as compared with \$316,740,000 in 1919, a decrease of 24.2 per cent in value of products. In addition soap products to the value of \$21,140,000 were produced in 1919 by establishments classified in other industries; corresponding figures for 1921 are not yet available.

The statistics for 1921 and 1919 are summarized in the following statement. The figures for 1921 are preliminary and subject to such change and correction as may be found necessary upon further examination of the original reports.

	1921*	1919*	Per Cent of Decrease
Number of establishments	283	279	...
Persons engaged	23,022	28,919	20.4
Proprietors and firm members	103	183	43.7
Salaried employees	6,361	8,300	23.4
Wage earners (average number)	16,558	20,436	19.0
Salaries and wages	\$32,566,000	\$35,400,000	8.0
Salaries	13,701,000	14,172,000	3.3
Wages	18,865,000	21,228,000	11.1
Paid for contract work	614,000	640,000	4.0
Cost of materials	150,356,000	238,519,000	37.0
Value of products	240,116,000	316,740,000	24.2
Value added by manufacture †	89,760,000	78,221,000	14.8‡

* Statistics for establishments having production valued at less than \$5,000 are not included in the figures for 1921; 69 establishments of this class reported 34 wage earners and products aggregating \$181,800 in value. For 1919, however, data for 69 establishments of this class, reporting 32 wage earners and products valued at \$130,100, are included in the figures with exception of the item "number of establishments." † Denotes increase. ‡ Value of products less cost of materials.

Detailed statistics of products for the years 1921 and 1919 are given in the following table, though figures for soap and associated products produced as subsidiary products by establishments in other industries, aggregating \$21,140,000 in 1919, are not at present available for 1921; hence all items are not actually comparable.

	1921	1919
Total value	\$240,116,000	\$337,880,000
The soap industry	\$240,116,000	\$316,740,000
Subsidiary soap products from other industries	*	21,140,000
Hard soaps:		
Quantity, lb.	1,741,002,000	1,855,257,000
Tallow, foats and olein soaps	903,258,000	1,072,390,000
Toilet soap	195,347,000	179,350,000
Dye soap	1,319,000	21,710,000
Soap chips	143,915,000	181,837,000
Other hard soaps	497,163,000	399,970,000
Value	\$163,041,000	\$227,051,000
Powdered soaps:		
Quantity, pounds	576,270,000	466,536,000
Abrasive	198,087,000	..
Non-abrasive	378,183,000	..
Value	\$29,144,000	†
Liquid soap:		
Pounds	5,965,000	10,033,000
Value	\$768,000	\$1,255,000
Soft soap:		
Pounds	50,756,000	74,463,000
Value	\$2,313,000	\$3,925,000
Special soap articles:		
Pounds	26,183,000	36,302,000
Value	\$2,269,000	\$3,568,000
Glycerin:		
Crude, for sale—		
Pounds	19,710,000	18,228,000
Value	\$1,912,000	\$2,433,000
Refined, for sale—		
Pounds	39,307,000	47,377,000
Value	\$6,088,000	\$11,461,000
Stearin:		
Pounds	3,223,000	3,140,000
Value	\$316,000	\$825,000
Candle pitch:		
Pounds	5,958,000	5,211,000
Value	\$92,000	\$91,000
Candles:		
Pounds	4,359,000	5,483,000
Value	\$327,000	\$819,000
Red oil (commercial olein acid):		
Gallons	930,000	433,000
Value	\$416,000	\$476,000
Perfumes and toilet preparations:		
Value	\$15,115,000	\$12,635,000
All other products	\$18,315,000	\$73,290,000

* Figures not yet available. † Included above with value of hard soaps.

X-Ray Examination of Steel Castings

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THE X-ray examination of castings promises to become one of the important methods of testing in foundry practice. It is important to know within what limits the method is applicable and to know the factors that determine those limits. Experiments recently conducted at Watertown Arsenal have been concerned with the practical limits and working equations in metal radiography.

Probably an impression is general that the utility of the X-ray in revealing hidden defects is quite limited, owing to the relative opacity of metal. While it is easy to radiograph a man's pelvis, measuring perhaps 12 in. side to side, a "twenty-two" bullet produces a dense shadow. Therefore we find *Chemical & Metallurgical Engineering* stating in an editorial (Feb. 15, 1922) entitled "X-Ray for Routine Testing" that the enormous difficulties seem to limit the use of radiography to moderate sections of metals of low atomic weight. Furthermore, Circular 113 of the Bureau of Standards, on "Structure and Related Properties of Metals," states that "an examination by means of X-rays is often of value if the specimen is not too large. . . . Specimens of steel to be examined by this means should not exceed $\frac{1}{2}$ in. in thickness."

In contradistinction to these accepted limitations, we have found at Watertown Arsenal that the limit of penetrability based on 30-minute exposure with commercial apparatus is approximately 3 in. of steel! Anticipating the subject somewhat, Figs. 1, 2 and 3 show what has been done with relatively heavy castings to be made for air bombs. The pattern was made up and an experimental casting poured. This was sent in to the laboratory for radiographing before the risers were cut off. Fig. 1 shows the casting as we received it; it weighed about 400 lb. Radiographs were made through various points

marked in chalk on the casting and prints of these, properly indicated, were furnished to the foundry. No defects of importance appeared except in the section through the nose. Fig. 2 is a print of a film placed horizontally inside the shell and exposed to rays traveling along the axis of the casting through slightly over 2 in. of metal. The three dark areas are shadows of the columnar risers. It was obvious that the risers were not feeding properly, and a change in the design of these remedied the difficulty. The casting was later cut up for study, and Fig. 3 is a photograph showing some of the holes represented by the spots shown on Fig. 2.

It may be objected that the information given by the X-ray might have been found by merely sawing up the casting. Even so, *complete* information is given by the X-ray far quicker and cheaper. It is no small matter to cut up heavy steel sections. Furthermore, the X-ray is of especial value in assuring oneself than an unsawed casting is sound in its vital parts. Thus sample castings are completely radiographed at the arsenal to make sure they are free from internal defects.

The questions that naturally come up for solution are: How should the exposure vary with the thickness? What is the limiting thickness of metal that may be radiographed with existing apparatus? What is the magnitude of the faults which gives certain markings on the plate? What is the limiting size of fault that may be detected under practical conditions?

With regard to the first question, How should the exposure vary with the thickness? It is possible to develop certain mathematical equations showing the relationships between the several variables involved. This work is outlined in the appendix. Practical application of theory is hampered by the fact that fluorescent screens are ordinarily

It Is Possible to Locate $\frac{1}{16}$ -In. Flaws in Steel 3 In. Thick With a 30-Minute Exposure From Commercial X-Ray Tubes—Correspondingly Smaller Defects Can Be Likewise Revealed in Thinner Sections



FIG. 1—400-LB. AIR BOMB CASTING TO BE RADIOGRAPHED



FIG. 2—RADIOGRAPH OF NOSE, SHOWING MANY BLOWHOLES. REDUCED ONE-HALF

used to intensify the direct effect of the ray, and these screens deteriorate with use. Thus a photographic plate or film—which is covered by an emulsion sensitive to X-ray impact as well as to light rays—is covered front and rear by a screen impregnated with salts which visibly glow when struck by X-rays. Thus the photographic effect recorded is that due to the direct action of the rays plus that due to the fluorescence of the screens. The latter effect may amount to fifteen times the former.

In order to get experimental curves showing relation of exposure to thickness, an echelon was made of eight pieces of transformer iron 0.03 in. thick and differing in length by $\frac{1}{8}$ -in. steps; the pile varied from 0.03 to 0.24 in. thick, by eight equal steps. A number of steel strips 8 in. long and of various thicknesses were then prepared, stacked up

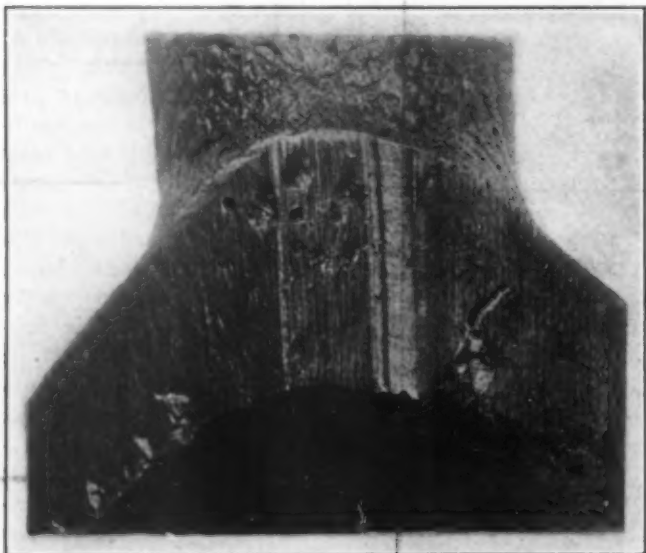


FIG. 3—CONDITION OF NOSE WHEN SAWED APART. CASTING IS 2 INCHES THICK

and the echelon placed on top of the pile, whereupon the whole was radiographed. Patterson "cleanable" intensifying screens were used. These screens were new and had their maximum sensitiveness. A series of negatives was made at varying times—other conditions being constant—and one picked out which showed clear or nearly clear under the thick end of the echelon and a regular graduation of density under the other steps. One film was selected and step 4 of this was arbitrarily taken as a standard for judging other negatives. Then a series of films was taken through piles of different height, and all of them were compared with the standard. The thickness of steel plus the thickness of transformer iron under the step that exactly matched the standard density was plotted against the corresponding "exposure." ("Exposure" means time of exposure multiplied by the current flowing through the Coolidge tube.)

Results of individual determinations are shown by dots on Fig. 4. As shown, two series of negatives were made, one when 100 kv. potential was impressed on the Coolidge tube, and the other under 195 kv. Curves A and B are figured according to the theory, with constants so chosen as to fit the observed values as closely as possible. A family of similar curves is also drawn,

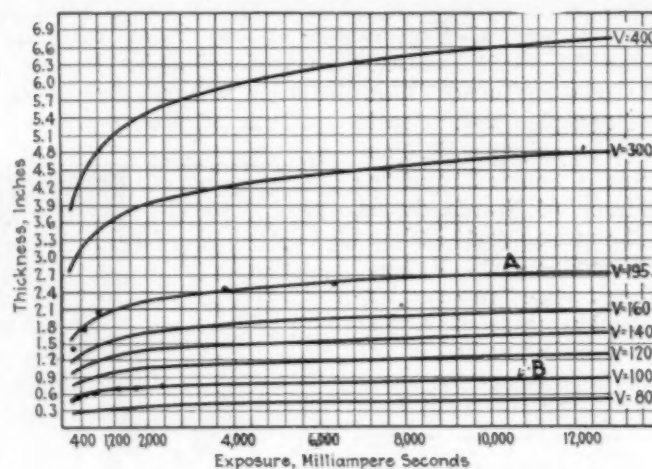


FIG. 4—RELATION BETWEEN THICKNESS OF STEEL PENETRATED, TIME OF EXPOSURE AND VOLTAGE, AND CURRENT THROUGH X-RAY TUBE

checked by experiment on voltages up to 230 kv., and assumed by extrapolation for higher.

The curves shown in Fig. 4 are practical working curves and are used in our laboratory as a guide to the necessary exposure for a given specimen. Actual exposures are plotted rather than logarithm of exposure because of greater convenience in use. The tube which we use can be operated at 200 kv., then consuming 7 milliamperes of current. In order to get any work done it is necessary to limit the time for making a negative to 30 minutes. The "exposure" therefore is 30 minutes \times 60 seconds \times 7 milliamperes, or 12,600 milliamperereconds. Running up the vertical ordinate corresponding to 12,600 to slightly above the curve marked V-195 gives a value of 2.9 in. for the limit of penetrability at a distance of 17 in. from the target.

In practice we have radiographed 3.1 in. of steel with the film at a distance of 13 in. from the target, and the film was somewhat more dense than the standard used above.¹ Hence it is probable that 2.9 in. is

¹Since the above was written we have penetrated 4.1 in. of steel, but under conditions of varying voltage so that it was not possible to check the equation.

fairly conservative. With a 300-kv. tube the curve indicates that we would be able to penetrate about 4.8 in. of steel, and with a 400-kv. about 6.8 in. of steel, using the same exposure (12,600).

Such tubes are needed. One of the difficulties today in metal radiography is the limitation of possible penetration. Greater penetration may be had either by increasing the transmitted radiation or by increasing the sensitiveness of the film system. To aid in the latter respects screens will undoubtedly be improved. Bulbs must be improved to take a higher potential rather than a heavier current. This fact is illustrated in Fig. 4. If we double the power consumption in a 195-kv. tube by doubling the current, we double the "exposure." But for long exposures the increase in penetration is very small indeed—the curve flattens out almost to horizontal. If, however, we double the power consumed in the bulb by doubling the potential (200 kv. to 400 kv.), the current remaining the same, we change the thickness that can be radiographed in the same exposure (12,600) from 2.9 to 6.7 in., a gain of 3.8 in.

SIZE OF CAVITIES WHICH CAN BE DETECTED

To determine the magnitude of a fault it is necessary to consider the area of the image and its relative density. If the cavity is sufficiently large, as compared to the focal spot in the X-ray tube—and sufficiently close to the film, so that definite, unblurred outlines occur, the image will be a scenographic projection of the fault. This is illustrated in diagram D of Fig. 5. Under these conditions, if the cavity is roughly spherical, this projection will be related to the section through the fault parallel to the film by the laws of geometry. The area of the section may be calculated from the area of the image, the distances from the target to the flaw, the distance from the target to the film, and the inclination of the film to the axis of the



FIG. 6—IMAGE OF TUNGSTEN TARGET OF COOLIDGE TUBE TAKEN THROUGH A PINHOLE IN A LEAD SHEET

X-ray beam through the flaw. If the cavity is not spherical and its major diameter is inclined to the axis of the X-ray beam through the cavity, the area of a section of the cavity usually cannot be found from the area of the image given on one film. If the fault is small in comparison to the area of the focal spot in the Coolidge tube, the cavity acts like the aperture of a pinhole camera.

The "image" appearing on the developed film is the image of the focal spot of the target rather than the image of the flaw. This pinhole image depends upon the variables that would affect the image in a pinhole camera—viz., the relative distances of the film and target from the hole, the area of the hole and the area of the focal spot of the target. For cavities small enough a true image of the focal spot would occur. Such an exposure is shown in Fig. 6. This is a very sharp view of the whole target—it shows the focal spot from which most of the X-rays emanate, together with the outlines of the target and some of the supporting stem, all of which is excited to emit resonance radiation.³

Images produced by somewhat larger cavities would

be indefinite, as shown in sketch A in Fig. 5. For still larger cavities the outlines of the fault would begin to appear (sketch B), and for cavities sufficiently large the image would present the sharply defined outline of the projection of the cavity (sketch C). In the case of the pure pinhole image the area of the section of the fault could not be calculated; where the outline of the cavity appears it is possible to calculate the area in some cases as outlined above. In practice most of the types of images sketched in Fig. 5 appear, sometimes all on one negative. However, a pure pinhole image of the focal spot such as shown in Fig. 6 has not been surely identified in practical exposures on steel castings.

These principles may be illustrated by X-ray exposures of holes in a lead sheet. Fig. 7 is the radiograph of a piece of lead sheet in which holes were drilled ranging in diameter from 0.032 up to 0.227 in. There was one large irregular hole made with a file.

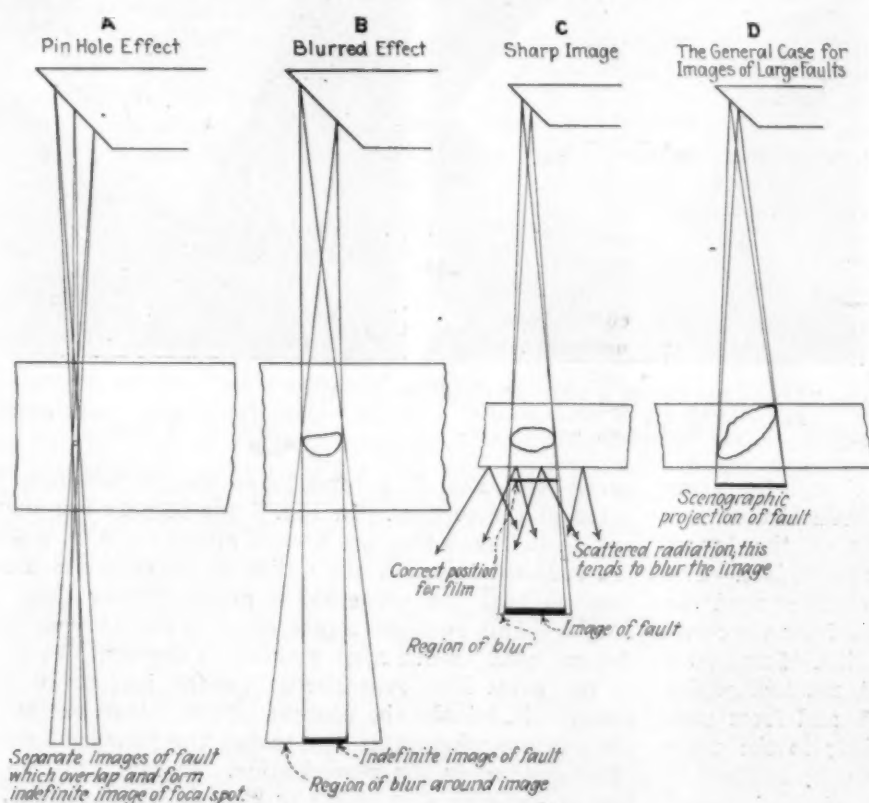


FIG. 5—DIAGRAM SHOWING HOW IMAGE VARIES ACCORDING TO SIZE OF DEFECT AND PLACEMENT OF FILM

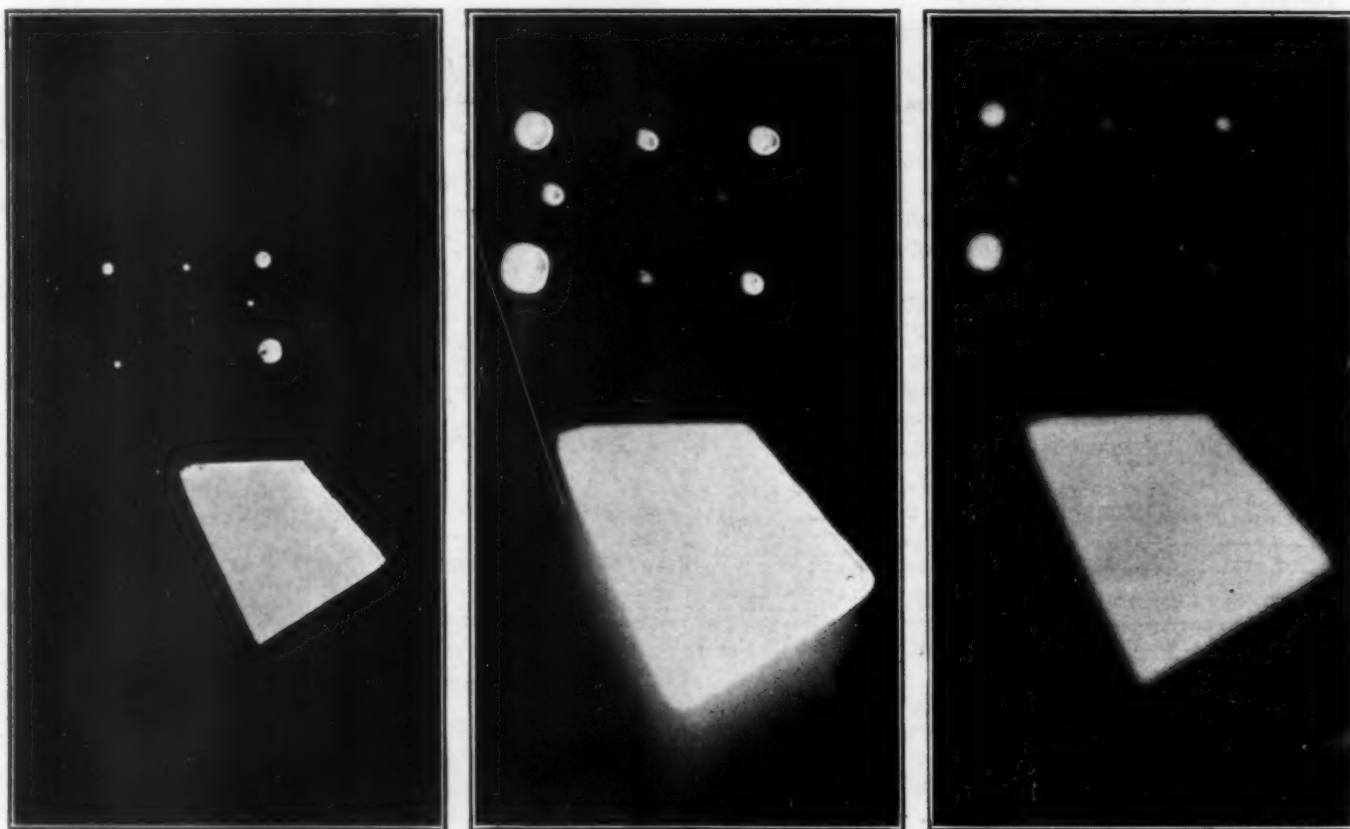
³"X-Ray Studies," page 95. General Electric Research Laboratory, 1919. Dr. Coolidge has explained this effect as due to wandering electrons that do not hit the focal area but reach other parts of the target.

The smallest hole was carefully cleared. Some of the other small holes contained metal shreds which were purposely left so as to give the effect of irregularly shaped small holes. The film was placed 1 in. below the lead. The images appear sharp, even the metal shreds showing.

Fig. 8 represents a radiograph of the same piece of lead, but here the lead is $11\frac{1}{2}$ in. away from the film. There was no metal interposed except the aluminum top of the cassette holder. In this picture the smaller holes show a distinct image of the focal spot of the target. This effect is the same for the cleared central hole and for the irregularly shaped small holes. The peculiar spiral appearance at the tiny central hole and the one at the left is not accidental—it is a correct image of the focus, and shows details lacking from the round white spot of Fig. 6. Fig. 10 shows a negative print of a film registering a focal-spot image taken through a pinhole 0.017 in. in diameter with the film 18 in. from the lead. The negatives for these show

of the whole target that appears as tails below the largest drill holes and the trail of light below the large irregular hole. Fig. 9 represents a radiograph of the same lead sheet, but in this case 0.35 in. of steel was introduced just beneath the lead, and the film was $11\frac{1}{2}$ in. from the lead. An attempt was made in this exposure to bring out the effect of radiation from the bottom of the steel and to illustrate the effect of the interposition of metal on definition.

A comparison of Figs. 8 and 9 shows that the relative contrast is less where additional metal is interposed. This is due to the fact that radiation from the bottom of the steel affects parts of the negative which formerly were completely shielded by the lead. The definition in Fig. 9 is, however, somewhat better, at least at the corners of the large image. The blurring effect and the "tails" caused by the characteristic radiation from the target support are missing. This radiation being less penetrating than the radiation from the focal spot, it is entirely absorbed by the iron. When Fig. 8 is com-



FIGS. 7, 8 AND 9—RADIOGRAPHS OF A PERFORATED LEAD SHEET

Fig. 7—Film 1 in. below lead.
No screen.

Fig. 8—Film $11\frac{1}{2}$ in. below lead.
No screen.

Fig. 9—Film $11\frac{1}{2}$ in. below lead. Screen:
0.35 in. of steel.

more than is evident in the print, even though the latter has been slightly retouched. The cathode stream evidently plays on certain favored spots on the target which may be small irregularities in the surface. The stream, however, tends to describe a circle around the outer edge of the focal area and travels from the spots to the outer circle by definite spiral paths. Sometimes as many as seven spots were counted, most of which were near the center of the focal area, and from each of these there was a spiral path leading to the outer circle.

There is also evident in Fig. 8 the effect of X-rays coming from other parts of the target, shown so clearly in Fig. 6. This radiation causes the indefinite image

pared with Fig. 7, a remarkable loss of definition is noted at the corners. In Fig. 7 the corners are sharp angles, in Fig. 8 they are arcs of circles; in Fig. 9 they are rounded also, but the radius of curvature is much less, so that the corners are much sharper than in Fig. 8. This rounded corner effect is due to a sharply defined band (much more evident in the negative than in the print here reproduced) located just inside the image. It follows the contour of the image except at the corners where this line makes the rounded corner effect noticed in the reproduction. In fact, this dense line is the edge that shows in Fig. 8. In the negative for Fig. 9 the line is still present but is less pronounced and it makes a much sharper turn at the corners. In

Fig. 11 the line is missing entirely. The latter figure is a negative print of a sheet of lead bent sharply around the end of a screwdriver and squeezed home with pliers. The sharp angle is faithfully reproduced.

The band causing rounded corners is undoubtedly due to X-rays reflected from lead crystals in the vertical surfaces of the holes. It travels toward the interior of the image as the film is moved away. Since the sheet of steel interposed in Fig. 9 filters out much of this scattering radiation, the band formed by the reflection of shorter wave lengths is reduced nearly to a line, and follows the contour more closely. Fig. 11 was taken through 2.35 in. of steel, which entirely absorbed the lead



FIG. 10—PINHOLE IMAGE OF FOCAL SPOT (RETOUCHED NEGATIVE PRINT)

radiation. Therefore the edge of the image is less definitely marked due to the absence of the band, but the corners are faithfully reproduced. Another negative too faint for reproduction was taken of a V-shaped opening in a piece of lead sheet $\frac{1}{2}$ in. thick through 3.1 in. of steel. The definition was as sharp as that illustrated in Fig. 11. We concluded that the definition remains sharp as long as the image is detectable, no matter how much metal is being penetrated, except where pinhole effects occur.

The magnitude of the fault in the direction of the X-ray beams—i.e., the thickness of the fault—is usually of greater importance than the sectional area. In fact, an estimate of the sectional area can often be got from the thickness of the fault and a general knowledge of blowholes and pipes, without relying on the geometric relationships sketches in Fig. 5.

However, it is difficult or impossible to arrive at definite conclusions on the thickness of a cavity from an inspection of the negative. In order to determine the thickness of the fault the relative density of the image to the density of the adjacent portion of the film must be considered. If that ratio is great—i.e., there is much contrast—the magnitude of the fault is apt to be considerable, but densitometer measurements would in most cases not give reliable data on which to compute definite measurements. The difficulty comes from the fact that the density in a photographic film is not a linear function of the exposure, as noted in equation 2 of the appendix. X-ray exposures usually fall in what is known as the "underexposed" portion of the curve. The image of a fault may fall near the bend of the curve where the slope changes rapidly, while the density of the adjacent portions of the film may come further down on a nearly straight portion. Therefore the densities of the negative may not give direct information on the size of the blowhole. If the film were exposed so that both portions of the film fell in the correct exposure region, then a linear relationship could be established that would give a definite measure of the thickness of the fault. However, this is not practicable, because it would increase the time of exposure too much.

The problem of getting a relationship between the relative densities of the image and adjacent film and the thickness of the fault is an important one. It is planned to attack the problem in this laboratory. We judge the magnitude of the fault by the density of the

image at present, but we realize that our judgment is more or less a guess.

The value of the radiographic method as a detector of flaws can be determined more accurately by relatively simple experiments. Obviously the relative density of the image will depend upon the relative thickness of metal traversed by the radiation in passing through the region in which the fault occurs and the region adjacent to this. If we adjust the exposure so that there is no visible density in the developed negative in the region adjacent to the image and then reduce the magnitude of the experimental flaw until its image is barely perceptible, we then have determined the limit of magnitude of flaw that can be detected. Experiments of this sort showed that with a steel plate $\frac{1}{2}$ in. thick a difference of 0.0005 in. could be readily detected. This amounts to a flaw thickness of one part in one thousand.

However, this experiment is misleading. If instead of having one part of the film clear and apparently unaffected by the rays, both parts are exposed "(underexposed" in the sense of equation 2 in the appendix), then the detection of the faint image is more difficult. In order to test this more general case a steel plate 8 in. long was ground so as to form a wedge 0.5 in. thick at one end and 0.492 in. thick at the other. This wedge was divided into 1-in. sections by lead strips and radiographed so that the negative under the thick end was nearly clear. The rest of the negative showed bands of increasing density. Other negatives were made with the steel built up to various thicknesses by the addition of parallel plates. Thus it was possible to distinguish between bands 2 and 4 with the steel $\frac{1}{2}$ in. thick. With the steel 1 in. thick the difference between bands 2 and 7 could be detected. When the total steel was 1.2 in. thick, no difference could be found between one end of the film and the other.

These negatives show contrasts too faint for reproduction, or even for printing, but with good illumination the differences in density can be detected in the negative. Such experiments indicated that differences in metal thickness of about 5 parts in 1,000 could be detected in this way.

Still the test is hardly fair, because it is easier to detect slight differences in large areas where the total light coming to the eye might be materially different, even though the illumination of the two areas is nearly the same. It is much more difficult to detect small differences when one area is much greater than the other. These circumstances obtain, of course, when radiographing a small defect in a large section. It is possible, however, to use an illuminator and an exploring screen—that is, a screen with a hole in it so as to inclose the image to be detected against a minimum of adjacent



FIG. 11—TWO PIECES OF LEAD EXPOSED THROUGH 2.35 IN. OF STEEL. FILM 4 IN. FROM LEAD

film. If this is done, it should be possible to detect flaws of the ordinary magnitude indicated above. In order to hunt small images in a large field, test specimens were prepared by drilling holes of various diameters in a sheet of transformer iron 0.015 in. thick.

Other sheets 0.03 in. thick were similarly prepared. One of these was placed on a stack of steel plates and the whole radiographed. Using the 0.015-in. plate the smallest hole (0.03 in. in diameter) disappeared when shooting rays through 0.9 in.; the largest hole, 0.25 in., was still visible at 1.1 in. Using the 0.3-in. plate the holes disappeared at about 1.8 in., the smallest hole disappearing certainly at 1.6 in.

These experiments would place the limit of detectability for this particular case at somewhere near 15 parts in 1,000. That is, a blowhole 0.04 in. in diameter in a piece of steel 2.5 in. thick should be detectable under ordinary exposures of 10,000 milliamperes-seconds. This is the upper limit. It is probably better to regard the limit for practical work at about 2 per cent.

The surface markings on a casting are often of greater magnitude than this. In such cases doubt may arise as to whether a dense spot in a negative is a surface mark or a hidden flaw. Comparison with the original casting may remove the doubt, but in important cases we use a stereoscope. Stereoscopic negatives are taken by making two exposures under as nearly identical conditions as possible, except that the X-ray tube is displaced the distance center to center of the observer's eyes. These two negatives, properly mounted, viewed in a stereoscope enable the operator to distinguish very definitely between the surface markings and the inner flaws, because they then give the illusion of depth—the defect appears in its proper position in space. This method gives the operator definite results with a little practice. In fact, the stereoscope greatly extends the usefulness of the radiographic method, and we regard it essential equipment of the laboratory.

The radiographic process as used in foundry testing is most useful to detect the existence of flaws; it is only in special cases that the exact outline of the flaw must be known. Then the sharpness of definition is of chief importance. The effect of secondary radiation is sometimes spoken of as an effect that tends to destroy definition.

Secondary radiation is in some ways analogous to the effect of light shining in a fog. The water particles reflect and refract the light in all directions so that all objects are seen in uncertain outline. If the photographic films were actually within the body of the metallic substance, the same shadowy outlines would be produced. Since the metal and film are separated, the scattering rays act differently from light in a fog principally because X-rays are much more nearly monochromatic than ordinary sunlight, which, as we all know, is a mixture of the rainbow hues. Scattered

X-radiation therefore may be thought of as monochromatic, its wave-length depending upon the characteristic frequencies of the metallic atoms. This radiation is most easily absorbed by the neighboring atoms so that most of the scattered radiation is absorbed by the metal itself. There is a certain amount escaping from a thin layer next to the photographic plate. This is indicated in sketch *C* of Fig. 5. If, as usually happens, the film is perpendicular to the axis of the X-ray beam, that portion of the scattered radiation that originates within the metal will have its components selectively absorbed so that the emergent components will be greatest in the direction of the radiation that proceeds from the target. This part of the scattered radiation assists in forming the image. The part that originated at or near the surface will proceed in all directions and will tend to fog the film.

That portion of the incident radiation that is transmitted directly through the metal will be highly monochromatic when it emerges (due to the filtering action of the metal) and its wave-length depends on the voltage across the bulb. Furthermore, its wave-length is very different from the wave-length of the scattered radiation and will probably have a different photographic effect. Hence even when photographing through thick metal a sharp image of the flaw should appear upon a background of general fog, except where the pinhole effect comes in. This would destroy the definition even when photographing with ordinary light.

SUMMARY

1. Our experiments in radiographing steel indicate that for material at a fixed distance from the target of the X-ray bulb and with the use of intensifying screens, the relationship between thickness, potential and exposure may be expressed by an equation of the form

$$y = (AV - B) \log x$$

where y is the thickness in inches, V is the potential in kilovolts, x is exposure expressed as the product of the current through the bulb in milliamperes multiplied by the exposure time in seconds. A and B are constants for our particular machine and with steel at a distance of 17 in. from the target. $A = 0.0048$ and $B = 0.26$.

2. The limit of penetrability based on 30 minutes exposure with apparatus commercially available is placed at approximately 3 in. of steel.

3. The magnitude of a fault may be judged from the area and relative density of the image only within rather indefinite limits.

4. For thickness of metal near the limit of penetrability a flaw approximately 2 per cent of the thickness of the metal may be detected.

5. Where the flaw is sufficiently large or sufficiently close to the film so that the pinhole effect is not important, the definition of the image remains sharp as long as the image is visually detectable in the negative.

Appendix

MATHEMATICAL RELATIONSHIPS

The law of absorption of X-rays is well known. If monochromatic radiation is incident upon material of given density, each successive increment of thickness absorbs an equal fraction of the radiation incident upon the sheet of material represented by that increment. This gives rise to the equation:

$$\rho = \frac{2.3}{y} (\log I_0 - \log I)$$

¹Kayé, "X-Rays," p. 100 (1914).

where ρ is the linear absorption coefficient, y is the thickness of material, I_0 is the incident radiation and I is the radiation transmitted. It is known that the coefficient ρ is proportional to the wave-length. The wave-length of the radiation is inversely proportional to the potential applied to the tube so that the equation could be written:

$$y = VK(\log I_0 - \log I) \quad (1)$$

where V represents the potential applied to the bulb and K is a constant depending upon the material, units employed, etc. The absorption law has been verified by ionization methods and also by

the direct action of the transmitted radiation on a photographic plate. In practice the photographic film is used with intensifying screens. The fluorescence of the screen varies with the wave length of the exciting radiation. This variation² makes it difficult to apply equation (1) where the density of the film is used to judge the exposure.

In equation (1) I and I_0 represent

²Millard B. Hodgson, "The Physical Characteristics of X-Ray Fluorescent Intensifying Screens," *Phys. Rev.*, vol. 12, No. 6, p. 431 (1918).

intensities. The photographic plate responds to intensity times time or total radiation. However, since I_0 and I occur as a ratio the equation may just as well be written in terms of the total radiation received by the material and plate respectively during time of exposure. The radiation that affects the plate is IT . The negative density is related to this IT term in accordance with the well-known Hurter and Driffield equation for photographic density,

$$D = A + B \log E \quad (2)$$

where D is the density of silver deposit, E is exposure and is represented by IT , A and B are constants.

If we, by trial, make the negatives all of the same density then IT should be a constant, provided the fluorescence of the screen does not change. Equation (2) may therefore be written

$$y = K'V(\log I_0T - A) = C' \log x - \frac{A'}{V} = \text{constant} \quad (3)$$

where x is put for I_0T .

The intensity of the X-ray beam is proportional to the current through the tube. Hence x may be expressed as the product of the tube current multiplied by the time of exposure. For want of a more convenient expression we have conformed to the usual practice and called this quantity the "exposure." It is the exposure to which the material rather than the film is subjected.

Equation (3) was checked by making a series of exposures of a pile of steel strips placed in echelon, as outlined above. "Exposure" for a given density on the film was then plotted against thickness of iron. The experimental values plotted along the 195- and 100-kv. curves (Fig. 4) were obtained in this way. It was found that in each case the values could be represented by an equation of the form of equation (3).

We were not successful in the attempt to fit the experimental data to a family of curves of the form $y = KV(\log x - A)$, since K and A both vary with V . For instance, the

195- and the 100-kv. curves are represented by the equations

$$y = 0.00343V(\log x - 0.02) \text{ and}$$

$$y = 0.00195V(\log x - 0.45) \quad (4)$$

respectively. This fit is not to be expected if the variation of the screen fluorescence with V affects the values of I . It is evident, however, that the experimental values represented by equations (4) may be represented nearly as well by equations of the form:

$$y = C \log x \quad (5)$$

where C is a parameter depending on V . For instance, equations (4) may be

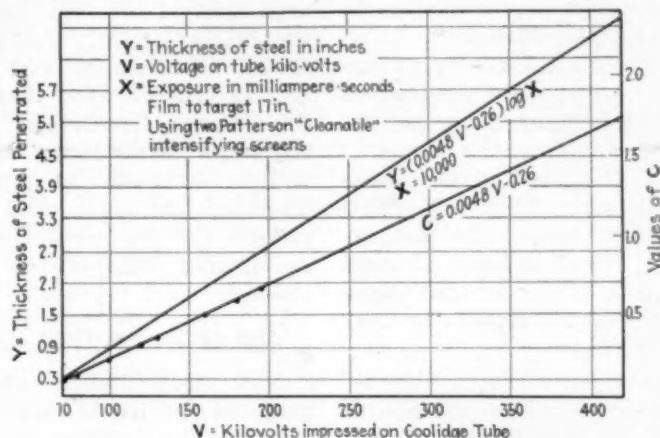


FIG. 12—THICKNESS OF METAL PENETRATED BY EXPOSURES OF 10,000 MILLIAMPERE-SECONDS

represented within the limits of experimental error by equations

$$y = 0.68 \log x$$

$$y = 0.22 \log x \quad (6)$$

Assuming equation (5) to be the type of equation best fitted for the curves, experimental values for C were obtained for a series of values of V and these were plotted against V . The points fell very accurately on a straight line between V equal 80 and V equal 195 kv. This line, shown in Fig. 5, curve A, has for its equation

$$C = 0.0048V - 0.26 \quad (7)$$

Substituting this value in equation (5) gives the relationship between potential, thickness, and exposure in the following equation:

$$y = (0.0048V - 0.26) \log x \quad (8)$$

where y is expressed in inches, V in kilovolts and x in milliamperere-seconds. Equations 7 and 8 are plotted in Fig. 12.

In obtaining equation (8) the film was kept at a fixed distance of 17 in. from the target. The exposure varies with the distance according to the inverse square law. The interposition of absorbing material in X-ray exposure is analogous to the interposition of an absorbing screen of sector disk in optical pyrometry: the effect is to change the apparent intensity of the source of illumination. The effective illumination on the film system is inversely proportional to the square of the distance from the target for the transmitted radiation, and it is sufficiently accurate for practical work to apply the same law to the exposure as we have used it in the foregoing discussion.

Equation (8) is empirical and does not hold for small values of V . This may be due to peculiarities of the screens or to the fact that for values of V above 100 kv. the transmitted radiation plays the more important part in the photographic action. This radiation, is, however, not all the radiation that affects the film. The fluorescent radiation from the bottom layer of the steel also

reaches the film and probably becomes relatively more important for smaller values of V down to about 10 kv., where the K absorption frequency for iron occurs. We have tested the relation down to 80 kv. with satisfactory results. It is probable that the relation holds for values greater than 200 kv., which is the upper limit of potentials possible with our machine. The curves for 300 kv. and 400 kv. in Fig. 4 are derived from values of C obtained by interpolating equation (7). If this is permissible, these curves give us a means of estimating the bulb potentials that will be necessary for going through greater thicknesses of material than is now possible with present equipment.

Sponge Iron

Work has been conducted for some time past at the Seattle station of the Bureau of Mines hoping to develop a method by which sponge iron can be made by using low-grade coals and iron ore in a direct-fired, rotary kiln. The sponge iron will be useful in the production of foundry iron, steel, and for the precipitation of copper from solutions resulting from leaching operations.

Tests will now be made in a small furnace that will treat about half a ton of ore per day. Attempts will be made to increase the rate of reduction of the iron oxide by adjusting the operating conditions of the furnace and the conditions of the charge. Concentration studies will be made on a product with a view to obtaining a high-grade sponge iron suitable for melting in an electric furnace, or for use in precipitating copper from solution.

Melting this sponge to foundry iron involves its carburization. Consequently the latter reaction has been studied on a laboratory scale and is to be continued on a commercial scale, using some of the local commercial

electric furnaces and foundry cupolas. A study of the mechanism of carburization and of the causes of graphitization will be conducted in the laboratory. After the above studies have been completed, the conditions determined therein will be applied to the melting of sponge iron.

Steel Treating to Publish Data Sheets

As a service to its members, the American Society for Steel Treating plans to prepare, publish and distribute, in loose-leaf form, data sheets relating to steel treating. These sheets will consist of tables, charts and pertinent information useful to the practicing metallurgist and heat treater.

It is proposed that the A.S.S.T. Handbook will have the same relationship to the steel treating industry as the S.A.E. Handbook to the automotive industry and Kent's Handbook to the engineering industry. D. K. Bullens, author of "Steel and Its Heat-Treatment," will be the editor, and the members of the society have been circularized asking them to send in suggestions concerning useful data to be included.

Legal Notes

BY WELLINGTON GUSTIN
Of the Chicago Bar

Decision Upholding Validity of Tungsten Filament Patents Brings Out Points on Foreign Process Patents

In the infringement suit brought by the General Electric Co. against F. Alexander and another involving the Just and Hanaman patent, No. 1,018,502 and the Langmuir patent, No. 1,180,159, the United States Circuit Court of Appeals has affirmed the decree of the District Court in favor of the plaintiff holding these patents valid.

These patents have been a great deal in the courts and the trial court gave the litigants the widest opportunity to put forward almost any conceivable fact, experiment or theory, with any and all defenses thereto, relating to validity or infringement, in order that litigation as to the validity of these patents should some day come to an end one way or the other.

The court finds that there is not a shred of merit to the attack on the validity of the Langmuir patent. It was contended that the American Sinding-Larsen patent, No. 672,019, invalidates the Langmuir patent. The court found that the Sinding-Larsen lamps have never been used, because the theory was wholly wrong. (277 Fed., 290.)

ARGUMENTS AGAINST VALIDITY OF JUST AND HANAMAN PATENT

The defendants were making and selling tungsten nitrogen lamps substantially identical with those made and sold by plaintiff under the asserted protection of the aforesaid patents and the Coolidge patent. The defenses urged against the validity of the Just and Hanaman patents were:

(1) That the same patentees obtained a German patent, 154,262, valid from April 15, 1903, for substantially the same invention as is revealed by their patent in suit applied for July 6, 1905; wherefore the patent at bar is invalid under a federal statute (Rev. Statutes, section 4,887) requiring foreign patents to be registered in this country within 2 years from the time they are obtained in another country.

(2) There is no infringement, because defendant's filaments contain an extremely small quantity of thoria, which prevents said filaments being the "pure, coherent, or homogeneous" tungsten filaments of Just and Hanaman. In point of fact defendant's filaments are admittedly made in the manner of Coolidge, and contain thoria for the reason and purposes set forth in Coolidge's disclosure.

INOPERATIVE FOREIGN PROCESS PATENT CANNOT DEFEAT PRODUCT PATENT

Passing on the first defense set out above, the court says the defense of invalidity under section 4,887 puts a heavy burden on a defendant. The various amendments to that section have not changed the truth of Judge Putnam's statement in a former case, 183 Fed., 823, that the act applies only to cases where the inventions actually claimed in the foreign and domestic patents are identical. It is not sufficient that the foreign

patent may disclose the invention of the later United States patent where it is not therein claimed.

Again it points out that the claim of the German patent is for a process which it says is wholly inoperative, in that it cannot produce the product covered by the patent in suit. The essential reason for this conclusion is that doing what the German patent calls upon one to do will never replace carbon or tungsten. The process rests upon the theory of replacement, and that theory has no substratum of fact.

The German patent being for a process and the American patent for a product, the court says it is true that, if the only use of the process is to make the product, such foreign process patents would and should affect an attempt to get American protection for the product. But that is not true in this case, the court finds. The German process patent will not make anybody's incandescent lamp filament, and especially will it not make the product of the patent in suit. Therefore the court holds that in no sense are the two patents for the same invention, whether one regards the proved facts or the language of disclosure and claims.

USE OF THORIA DOES NOT PREVENT INFRINGEMENT

Now the defendants admitted the use of Coolidge's thoria-containing filament; but as they were not being sued on the Coolidge patent they could not infringe here. A former decision in the Laco-Phillips case, 233 Fed., 96, specifically held that a Coolidge drawn filament infringed the Just and Hanaman patent, although it was an improvement of such striking nature that it completely drove all other tungsten filaments from the market.

Now the court points out that while impairment of function is no defense to infringement and improvement of function is oftentimes patentable matter of a very valuable kind, if the functioning of a patent is substantially appropriated by substantially using the patented means, infringement always exists. The object of all makers of light filaments is to get the best light, and what at present makes the tungsten filament the best light-giving means is pure, cohering and homogeneous tungsten. Tungsten of that kind is functioning just the same with or without the mechanical thoria stiffener. This is true, whether the slender thread of incandescence is made by Just and Hanaman, or by Coolidge, or by the defendants.

IMPREGNABLE INVENTION, SAYS COURT

Defendant Alexander and one Fabian were once partners trading as Alpha Electric Laboratories. This concern sold infringing lamps, whereupon this action was brought against the partners trading as aforesaid. Subsequently plaintiff learned that, before the bill was filed, the business was incorporated as Alpha Laboratories, Inc., at which time Alexander bought out Fabian and became the owner of all the shares in the new company. The corporation continued to do the same business, making and selling the infringing lamp. Suit was dismissed as to Fabian, but the decree against both the corporation and against Alexander personally was upheld.

The court says that "notwithstanding the ingenuity and ability with which the Just and Hanaman American patent has been attacked, it remains where it was and where it should be—the embodiment of an impregnable invention of the highest order."

Elastic Column Dynamometer for Hardness Testing

BY HERMAN A. HOLZ

A NUMBER of devices have been developed during recent years to measure the load in small static testing machines used in hardness testing by the ball or cone methods of Brinell or Ludwik.

The original Alpha machine made in Sweden and several American-made Brinell machines make use of a spring manometer gage which is checked either against a piston loaded with weights or against another spring manometer gage. The spring manometer, suffering from changes in the spring and temperature variations, is by no means a satisfactory instrument of precision. Amsler's hardness (Brinell and Ludwik) testing press utilizes the well known pendulum dynamometer for measuring the load on the indenting tool. It utilizes what is undoubtedly the most accurate and constant apparatus known to modern science for measuring the load. However, it is quite expensive, and is difficult to adjust or modify to meet a wide variety of special problems encountered in practice.

Some of the other schemes used for determining the load in hardness-testing apparatus are the deformation of calibrated springs (Guillery), the deformation of

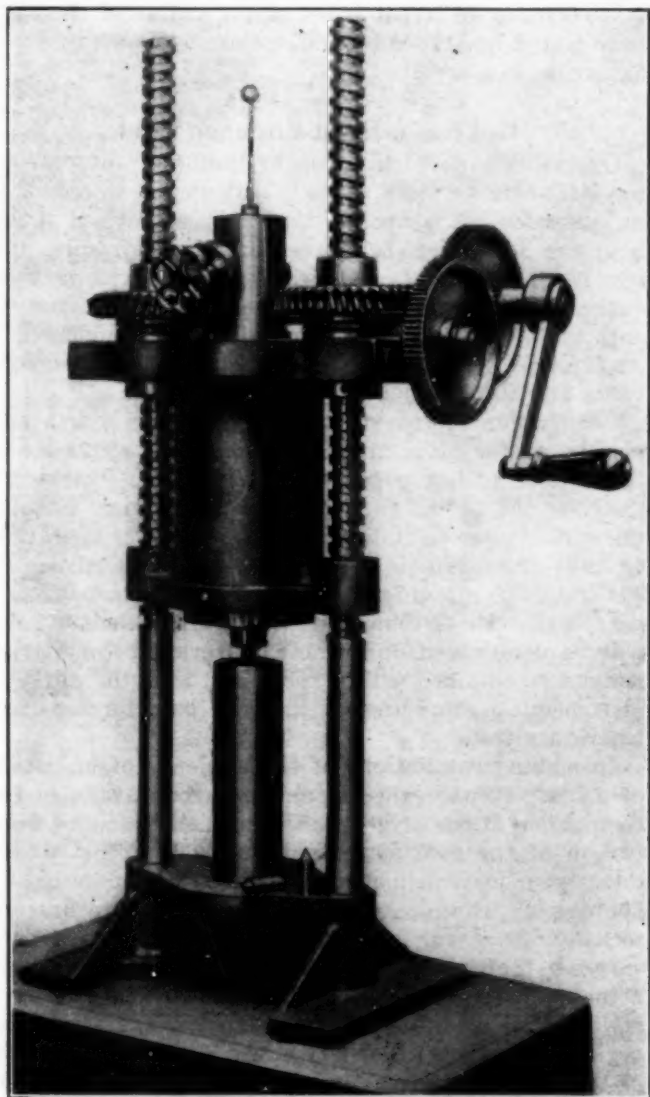


FIG. 1—HARDNESS TESTING MACHINE, VERTICAL TYPE

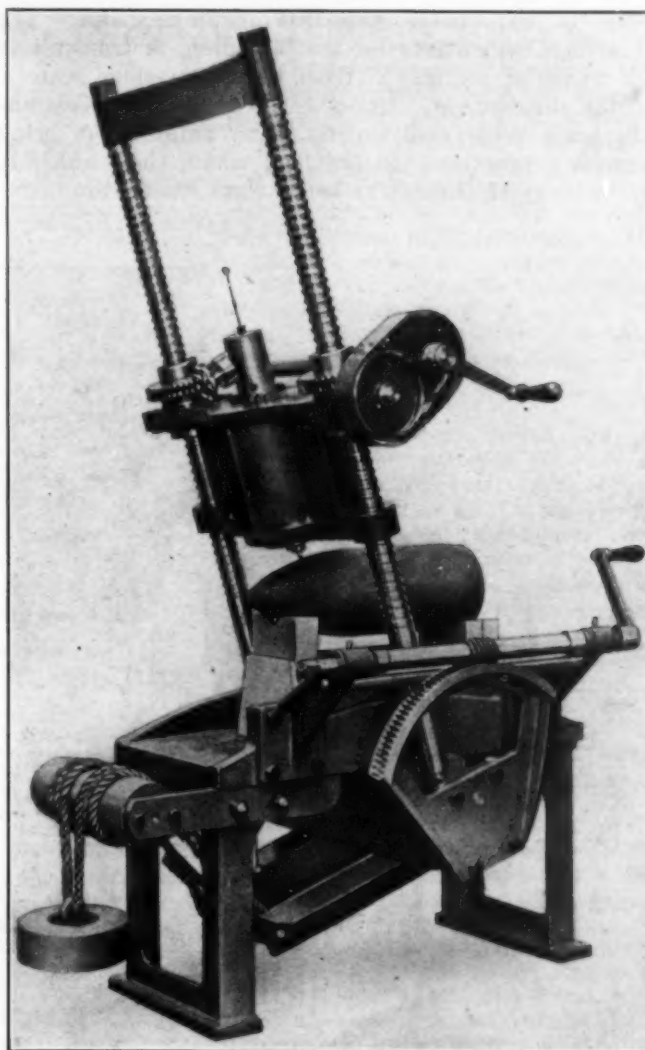


FIG. 2—HARDNESS TESTING MACHINE, SWINGING TYPE

the frame of the testing machine itself (Derihon), the balancing of weights by levers (Avery, Herbert, Riehle, etc.). Levers and knife edges subjected to heavy stresses, jerks, sudden releases and other slowly but progressively deteriorating influences are by no means ideal elements in the construction of testing machinery. Even in the large tensile machines, the lever type machines are being rapidly superseded by those machines which do not contain any knife edges.

Methods of *applying* the load do not vary so widely. In nearly every design a small hydraulic pump builds up pressure within a cylinder, and this pressure is transmitted to the testing point by means of closely fitting pistons and rods. Small hydraulic machines are not altogether suitable for continuous use in places where dust and soot are apt to get into valves, such as often occurs in heat-treating shops. The elastic column dynamometer described below imposes a load by a train of gears and screws, so that we now have practical, accurate and rugged instruments for measuring the load on hardness testers in which nothing can get out of order and that can be operated satisfactorily and correctly by anybody, in any position and at any range.

The principle used by Dr. Alfred J. Amsler in designing this dynamometer is illustrated in Fig. 3. The apparatus forms the upper part of a press; the material under test is pressed against plate *B* with a load *P*. The reaction is taken up by shoulders *A*, which are

securely connected to the base of the machine. The total load which acts on the test piece is transmitted by means of columns *C* from the compression plate *B* to the shoulders *A*. Under compression these columns shorten a very small amount, their deformation being always proportional to the load which they transmit, since they are loaded far below their elastic limit.

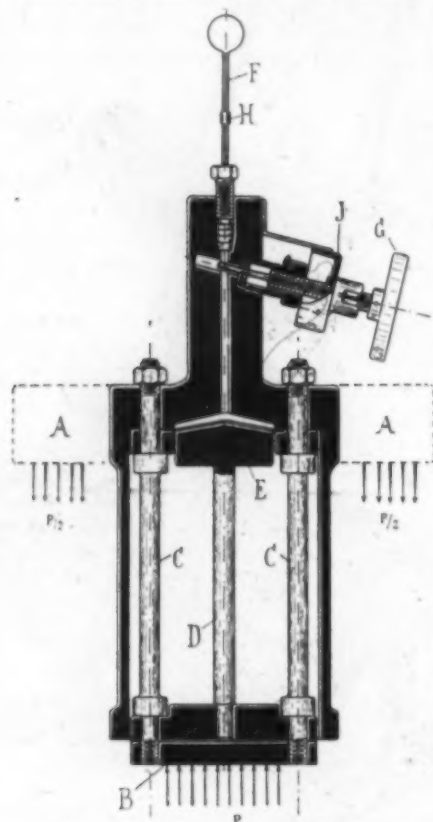


FIG. 3—WORKINGS OF ELASTIC COLUMN DYNAMOMETER

Central column *D* is loose and is not subjected to any stresses. It supports a piston *E* which moves in a small space filled with mercury. It will be readily understood that if columns *C* are shortened under load, piston *E* is raised a distance equal to the shortening of the columns. In rising it expels a quantity of mercury proportional to its movement into the capillary *F*. The quantity of mercury expelled is therefore proportional to the load *P* acting on plate *B* and is measured by the micrometer screw *G*, the end of which is immersed in the mercury.

The level of the mercury in the capillary can be adjusted to any desired height by turning the screw. The most practical manner of reading the load is to bring the meniscus to the fixed mark *H*, where it stood at "no load." The amount by which the screw is turned back is then the measure of the load applied. The dimensions of the apparatus are usually chosen in such manner that one complete revolution corresponds to 1,000 kg. pressure, and one division on the head to 10 kilos. When it is desired to apply a definite load, say 3,000 kilos, the micrometer is turned back three complete revolutions and then the load is gradually increased until the level of the mercury returns to its original height.

Readings are independent of the bore of the capillary *F*, so that an accidental breakage can be immediately replaced by another tube without influencing the accuracy of the apparatus. This dynamometer is very sensitive and at the same time of very rugged

construction; it can be overloaded only when the testing machine itself is being wrecked. Each dynamometer is carefully calibrated by dead load up to its full capacity; the calibration can be checked at any time by hanging the entire machine up by the compression plate *B*. The load then shown on the dynamometer should agree with the weight of the machine, and if other comparisons be thought desirable extra weights may be added to the machine base.

The practical application of this dynamometer is shown in Fig. 1, a hardness-testing machine with two speeds; the high speed is applied to bring the ball quickly into its required position, the slow speed is used to apply the load. It is apparent that the main side screws can be made of any desired length and set at any reasonable distance center to center, so that very large pieces—like great gear wheels—can be tested at various points on the rim or teeth.

An especially interesting application is shown in Fig. 2, of a machine developed for the French Government. The entire frame can be rotated about an axis placed below the lower base frame of the machine. A counterpoise balances the weight of the frame and of the moving head, so that any required adjustments require very little power. The ball itself follows the curvature of the pointed part of the shell, so that it is always in the proper position for testing. The radius of arc of the circle described by the ball can be adjusted from 6 in. to 40 in.; it is set at the radius of the part to be tested, and the latter held in place by an appropriate fixture or steady rest.

Coke as a Blast-Furnace Fuel

Operators believe that loss by "solution" of coke in the blast-furnace stack gases is detrimental to economical operation. A laboratory test has been devised at the Southern station of the Bureau of Mines by which the relative reactivity of cokes with carbon dioxide may be quantitatively determined. Correlation of test results with those of actual furnace practice will be undertaken on furnaces operating on coke from Alabama, Pennsylvania and Illinois coal.

Combustion of coke in the blast-furnace hearth has also been studied in the Birmingham district. Additional work will be done at furnaces in the Pittsburgh districts and at the furnaces of the St. Louis Coke & Chemical Co. at Granite City, Ill., which are operating on coke from Illinois coal. By means of analyses of gas taken from different parts of the blast-furnace hearth, the rate of combustion of different kinds of coke will be determined under actual operating conditions. Results so obtained will be correlated with the physical and chemical properties of the coke as determined by laboratory tests.

In making calculations of the efficiency of operation of a blast furnace, the amount of carbon available for combustion at the tuyeres is taken as the so-called fixed carbon of the proximate analysis. The official determination of volatile matter is made at a temperature of 950 deg. C. Since coke is subjected to temperatures up to 1,800 deg. C. before being burned at the blast-furnace tuyeres, there is the possibility that less carbon is actually "fixed" in a condition to reach the tuyeres than is indicated by the ordinary proximate analysis. Experiments are now under way at the Birmingham station of the Bureau of Mines in which the volatile matter of several varieties of metallurgical coke will be determined at temperatures up to 1,700 deg. C.

Recent Chemical & Metallurgical Patents

Coal Carbonization—In two patents Charles C. Bussey describes the apparatus and procedure for treating carbonaceous materials and recovery of the volatile hydrocarbon products of destructive distillation. The process is essentially an internally fired vertical retort or combination of producer and vertical retort. The process and apparatus are like those which were tested out several years ago in Brooklyn and later used to a limited extent in or near Louisville, Ky. One of the important features, more or less novel in this apparatus, is the reciprocating grate at the bottom which by alternate forward and backward movement at controllable intervals provides for the ejection of the carbonized residue at the bottom of the retort. (1,432,275-6. Charles C. Bussey, assignor to Samuel E. Darby, trustee. Oct. 17, 1922.)

Evaporating Milk—Various objections to the ordinary vacuum pan method of evaporation of milk are claimed to have been overcome by a process patented by David D. Peebles of Eureka, Calif., and assigned to Bair, Peebles & Tooby of Eureka. Among these objections may be mentioned the high initial expense of installation of a vacuum pan system; the tendency of the liquor foaming and priming, and being carried over with the vapor escaping from the pan; adhesion of the concentrated material to the heated surfaces of the pan, thereby resulting in scorching; the need of special apparatus for homogenizing the milk; the necessity of maintaining a high temperature in the vacuum pan to prevent incubation of the bacteria, thereby breaking down the chemical constituents of the original milk; and finally the necessity of separate sterilizing apparatus at destructively high temperatures. The present invention consists in the continuous and successive circulation of the milk through a heater under pressure and an expansion chamber closed against access of surrounding air, the temperature of the milk being suddenly raised in the heater above the temperature at which the germination of the active organisms takes place and suddenly reduced in the expansion chamber to a temperature below that at which such germination is active, and removing the vapors resulting from the expansion of the water of the milk in a separate expansion chamber. At each successive cycle in the process a percentage of dehydration is effected and the milk is condensed and made more sterile without altering its chemical composition. The milk is heated to approximately 160 deg. F., which is a pasteurizing tem-

American Patents Issued Jan. 23, 1923

The following numbers have been selected from the latest available issue of the *Official Gazette* of the United States Patent Office because they appear to have pertinent interest for *Chem. & Met.* readers. They will be studied later by *Chem. & Met.*'s staff, and those which, in our judgment, are most worthy will be published in abstract. It is recognized that we cannot always anticipate our readers' interests and accordingly this advance list is published for the benefit of those who may not care to await our judgment and synopsis.

- 1,442,814—Device for Spraying Paint. F. R. Long; assigned to American Car & Foundry Co., New York.
- 1,442,818—Derivatives of 1:4 Naphthylenediamine. G. T. Morgan; assigned to Imperial Trust for the Encouragement of Scientific and Industrial Research.
- 1,443,077—Process for Producing Sulphides. A. Helbronner and P. Piperdant, Nantes, France.
- 1,443,094—Method of Making Phthalic Anhydride. H. Sasa, Tokyo, Japan.
- 1,443,149—Rubber Composition. P. Schidrowitz, London.
- 1,443,161—Coke Oven. G. A. Bolz, Rahway, N. J.
- 1,443,184—Centrifugal Separator. R. E. Lapham, Oakland, Calif.
- 1,443,189—Plates for Vulcanizing Press. A. C. V. Malm; assigned to E. W. Bliss Co., Brooklyn, N. Y.
- 1,443,220—Recovery of Nitrogen Oxides. P. A. Guye and A. Schmidt; assigned to "L'Azote Francaise" Co. of Paris.
- 1,443,221—Insulating Material. J. Hawkrige, D. Robertson, C. J. Nevine, of London.
- 1,443,221—Non-Freezing Attachment for Water Tank. F. W. McCauley, Goodes, Va.
- 1,443,328—Explosive. E. Herz, Vienna, Austria.
- 1,443,330—Determination of Naphthalene in Gas. W. H. Fulweiler; assigned to U. G. I. Co.

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

perature, and then cooled to the temperature of the vacuum under which the concentrator is operating. A tubular heater is employed, the milk being circulated through the tubes. (1,438,502. Dec. 12, 1922.)

Anthraquinone Dyes—Ewald Steinbuch, Franz Ackerman and Max Utzinger, of Basel, Switzerland, assignors to the Society of Chemical Industry in Basel, Switzerland, have patented a process for the manufacture of new condensation products of the anthraquinone series which contain in their molecule 1.3.5-triazine nuclei and constitute colored powders generally difficultly soluble in organic solvents and forming colored solutions with concen-

trated sulphuric acid. The condensation can be affected in such a manner that the respective anthraquinone and 1.3.5-triazine derivatives are left to react on each other for a sufficient length of time dissolved or suspended in suitable agents such as nitro-benzene, chlorobenzene, naphthalene, toluene, glacial acetic acid, etc., the temperature being maintained constant as desired. The solvent may also be omitted by simply melting together the respective compounds to which a catalytic agent, such as cuprous chloride, may be added if necessary. (1,437,783. Dec. 5, 1922.)

Chrome Dyes—Fritz Straub, of Basel, Switzerland, has patented a method of making chromium compounds of azo dyes by treating an alkaline solution of the dye with a complex chromium compound formed by the action of alkaline suspension of chromium hydroxide on organic compounds containing more than one hydroxyl group, as polyvalent alcohols and phenols, tannins, saccharides and derivatives of cellulose.

In an example, 46.8 parts of caustic potash are introduced gradually into 100 parts of aqueous paste of hydrate of chromium oxide, with stirring, care being taken that the temperature does not rise above 70 deg. C. After all the potassium hydroxide is dissolved, 20.8 parts of glycerine are added with stirring. The mass is heated to boiling and maintained in ebullition until all of the chromium hydrate is dissolved. To this solution is added 71.2 parts of the dye derived from 1-diazo-2-oxy-naphthalene-4-sulphuric acid and alpha-naphthol. The dye dissolves quickly and the dark blue coloration of the resulting solution turns rapidly to blue-violet. The mass is boiled for 10 hours in a vessel provided with a reflux condenser, the temperature of the reaction being 100 to 102 deg. C. The mass is then diluted with 600 parts of cold water and the liberated caustic potash is neutralized with mineral acid and the dye salted out, filtered and dried. (1,440,566. Jan. 2, 1923.)

Cellulose-Ether Solvent—A compound solvent for alkyl ethers of cellulose, comprising a mixture of methyl alcohol and toluene, is covered by a patent taken out by Stewart J. Carroll, of Rochester, N. Y., and assigned to the Eastman Kodak Co. The solvent is designed to be used for film dope, where a very viscous solution is desired. The proportions recommended vary between 25 to 50 of methanol and from 50 to 75 parts of toluene. (1,441,143. Jan. 2, 1923.)

High Explosives for Detonators—Fulminate of mercury has long been the chief initiating explosive of commercial importance used in detonators. Its great advantage over other initiating explosives is that by its use detonation is assured, either by the spit of a fuse or other means of ignition or by moderate percussion. On the other hand, it exhibits several undesirable properties

in that it is easily affected by moisture, its detonating value is diminished by compression, it has a relatively low brisance, which renders necessary the use of an inner capsule or reinforced shell when it is desired to use fulminate of mercury as a priming charge in the TNT type of detonator, and finally because it has a corrosive action on a number of metals and alloys, thereby rendering them unsuitable for detonator casings.

The heavy metal azides, which are salts of hydrazoic acid, have been proposed as a substitute for fulminate of mercury, but they also have their drawbacks in that they are not easily ignited. It would seem that the desirable properties of the two types of explosives might be obtained by a proper mixture of the two, but unfortunately the azides corrode some of the metals and alloys which are not affected by fulminate of mercury, so that there is really no metal which could be used for a casing for the combination explosive.

Bennett Grotta, of the Atlas Powder Co. experimental laboratory at Tamaqua, Pa., has been granted a patent covering the use of the mercurous salt of hydrazoic acid in combination with fulminate of mercury for use in detonators. The mercurous salt is not nearly as unstable as the mercuric salt, and seems to be admirably suited for admixture with mercury fulminate because both compounds, being salts of the same metal, may be mixed without danger of chemical action, and in the second place, because there is no appreciable action between such a mixture and shells which would be suitable for fulminate detonators. It is claimed that the mercurous compound, in contradistinction to lead azide, does not form supersensitive copper azide. The inventor attributes this to either of two explanations: First, to the comparative positions of the metals involved in the electromotive series, and second, to the comparative solubilities of mercurous azide and lead azide in water.

Another advantage of the mercurous azide over the better known lead compound is that it is not attacked by the carbon dioxide of the air with consequent liberation of hydrazoic acid which in turn may act upon the copper of the shell with the formation of the supersensitive copper azide.

It is claimed that from the standpoint of detonating efficiency, the admixture of small quantities of mercurous azide with fulminate of mercury produces most gratifying results. It is said that the advantageous effects of such mixtures hold equally true when the mixtures include suitable proportions of potassium chlorate. (1,439,099. Dec. 19, 1922.)

Purification of Naphthalene—In using this invention, crude naphthalene is distilled and the vapor passed through sulphuric acid of about 66 deg. Bé. at a temperature high enough to avoid condensation of the vapor. The temperature is usually 134 to 144 deg. C. at the preferable pressure, but the opera-

tion may be at various pressures with corresponding change of temperature. The impurity in the vapor is sulphonated and forms a byproduct in the acid residue which is described as "useful in the arts as ingredients of synthetic tanning liquor, for saponification of oils, or for other well-known uses to which crude sulphonic acids may be put." (1,438,710. S. P. Miller, assignor to The Barrett Co. Dec. 12, 1922.)

French Patents

Separating Constituents of a Gas Mixture—To the gas or gaseous mixture are added particles of a solid substance, held in suspension therein and of such a chemical nature as to combine with the particular constituent to be removed, with formation of a fume or a fog. This fog is then precipitated by a high-tension electrostatic field. (Fr. Pat. 534,879. A. L. Stinville.)

Purification of Liquids Contaminated by Phenol—Liquors contaminated by phenol may be evacuated into rivers following their filtration through a bed containing certain aerobic bacteria which destroy the phenol, presumably by oxidizing it to innocuous substances. A filtering bed of humus (to protect the bacteria) mixed with coke is prepared which allows access of air circulated through it either by suction or pressure. Through this filter-bed activated sludge (drawn from the aeration chambers of sewage treatment plants) is allowed to percolate, after which it is topped with a layer of farm manure. The waste liquor to be treated is then passed through the filter bed. This liquor is generally a residual ammoniacal liquor from a gas-works or a coke-oven plant, which has been diluted by water or, better still, by the effluent itself, until it has no longer a highly toxic effect upon the filter-bed bacteria—viz., until the phenol content has dropped to below 3 parts in 10,000. For instance, in the operation of the filter, 10 to 15 per cent of the effluent is evacuated into the river and 85 to 90 per cent is recirculated through the filter to which is added 10 to 15 per cent of crude residual liquor (sometimes 5 to 30 per cent). One cubic meter of the filter-bed composition is sufficient for treating 60 to 120 liters of residual liquor each 24 hours. Since the filter is operated continuously, the reproduction and the growth of the phenol-destroying microorganisms compensate the losses. If the losses become excessive, the degree of dilution may be increased or the flow reduced. The amount of inflowing liquor may even be stopped altogether, thereby affording time for the replacement of the killed bacteria. The optimum filtration temperature is 20 to 25 deg. C. In the residual ammoniacal liquors the sulphocyanates are likewise oxidized by the bacteria, although subsequently to the phenols. For this type of waste liquor it is advisable to effect, prior to purification by filtration, the removal of the solid and tarry constituents, as well as the sulphides

(CaS), by preliminary decantation followed by a filtration through an iron-oxide mass or blast-furnace slag. This may be supplemented by a special treatment for the elimination of the cyanogen compounds. (Fr. Pat. 533,922. The Koppers Co., Pittsburgh, Pa.)

Continuous Distillation of Bituminous Shales—This process consists in admitting air, occasionally even steam, into the lower part of a downwardly moving column of highly heated bituminous shale, whereby the residual carbon (10-12 per cent in the case of Autun shales) is converted into gas, the latent heat of which brings about the distillation of the upper layers of the shale column, and the condensable oils and the ammonia are swept out of the retort. In this manner an extraneous source of heat for carbonization is dispensed with. (Fr. Pat. 534,659. Société d'Etudes et de Recherches Minières du Centre.)

Separating Asphalt and Ozokerite From Hydrocarbons—Crude petroleum oils to be purified are subjected to a chemical treatment prior to distillation. The reagents proposed by the inventor are comparatively dilute sulphuric acid solutions (40 to 60 per cent H₂SO₄), to which small amounts of solutions of metallic salts have been added, particularly halogen derivatives of trivalent iron, the function of which consists in promoting the precipitation of the colloidal compounds present in the crude oils. The oils, after having undergone this treatment and having been subjected to a cooling process, abandon their solid hydrocarbons in the form of ozokerite and ceresin wax, and no longer in the form of a low-melting point paraffine. (Fr. Pat. 536,172. H. Neumann.)

Production of Metallic Powders—This process is applicable for instance to the pulverization of aluminum, magnesium, copper, zinc, etc., which metals are susceptible of undergoing superficial oxidation and also of combining with nitrogen. The metal is heated in the open air or in a closed crucible to a little above its melting point. The molten metal is then drawn off and subjected to the action of a jet of compressed nitrogen at a suitable temperature whereby it is solidified in the form of fine ellipsoidal globules. The nitrogen may be that extracted from the air, for instance in the form of waste combustion gases whose CO₂ has been removed by bubbling them through milk of lime. In the case of aluminum, for instance, the nitrogen forms at the surface of the globules a protecting layer of nitride which prevents access of atmospheric oxygen to the subadjacent metallic aluminum. (Fr. Pat. 532,470. J. Sejournet.)

Esters From Aluminum Alcoholate—Aluminum alcoholates may be obtained by the action of alcohols on aluminum amalgam or preferably on a ternary aluminum alloy, the latter being more readily prepared. By causing such an

alcoholate to act on an ester there is displacement of the alcoholic radicle of the ester by that of the alcoholate, provided these have a higher molecular weight. The yield is excellent. The acetic acid esters derived from secondary amyl alcohol, phenylethyl alcohol, and linalool have thus been obtained from ethyl acetate, and the phenyl acetic esters of amyl alcohol and phenyl ethyl alcohol from phenylacetic acid. The process is particularly applicable in the case of the esterification of tertiary alcohols which do not resist well the action of mineral acids, anhydrides or acid chlorides. It is also well adapted in those cases where the preparation of the ethyl esters is less onerous than that of the corresponding anhydrides or acid chlorides. (Fr. Pat. 531,960, Société Laboratoire-Usine.)

Aromatic Nitro-Amino Compounds—

The replacement of chlorine atoms of aromatic chloro-nitro compounds by amino-groups does not require that the reaction be carried out under pressure (in an autoclave) proving that ammonium acetate is used in a current of gaseous ammonia. The amino-derivative is separated by washing the reaction product with water. The ammonium acetate is used in a current of this manner have been prepared 2:4-dinitro-aniline, 1:3:4:6-diaminodinitrobenzene, 1:4:3:5-chloraminodinitrobenzene, 1:2:4:3:5-chlorodiaminodinitrobenzene, 1:2:4:5-dichloraminonitrobenzene, 1:2:4-aminochloronitrobenzene, 1:4:2-aminochloronitrobenzene, o-nitro-aniline. (Fr. Pat. 432,405. Société Chimique de la Grande Paroisse, Lille, France.)

Improved Hydrogenation of Naphthalene—A nickel catalyst suitable for the hydrogenation of naphthalene and much more active than that obtained by reduction of its oxide is obtained by forming it in a colloidal condition in the hydrocarbon itself. A current of hydrogen is passed into 1,000 parts of naphthalene and 5 parts of nickel carbonate heated to 220 to 250 deg. C. under a suitable pressure. The precipitated nickel carbonate is already in a finely divided condition. The dispersion is pushed even further by the liberation of carbon dioxide and the reduction process. (Fr. Pat. 533,033. Prax Chemische Versuchs und Verwertungs Gesellschaft m.b.H.)

De-inking Paper—The ordinary beater engine is equipped with a screen which holds back the pulp while the washing water is afforded free passage through it and through a circulating mechanism. In this engine a charge is made up composed of 1 ton (metric) of waste paper, 100 kg. of sodium carbonate, 320 hl. of water and 150 kg. of bentonite or analogous product. Bentonite is a clay having an exceedingly fine grain. The material used in this process should be such that at least one-half of its particles have a diameter less than 0.0015 mm. and 70 per cent of which is in a colloidal condi-

tion. The ink attaches itself to the colloid and is carried with it through the screen. After this operation an acid or an acid salt is used to neutralize the excess alkali and to brighten up the color of the paper. (Fr. Pat. 535,859, H. R. Eyrich and J. A. Schreiber.)

Production of Alumina and Aluminum Compounds—Bauxite is treated with nitric acid, and the iron is precipitated from the resulting solution. The purified solution gives pure aluminum nitrate, which, when calcined, yields alumina and nitrous vapors which are reconverted into nitric acid. The alumina may be extracted from the solution by any other method—for instance, by precipitation. (Fr. Pat. 529,569. Norsk Hydro-Elektrisk Kvaelestofaktieselskab, Christiania, Norway.)

Production of Aluminum and Potassium Compounds—Potash-bearing aluminous minerals, such as leucite or feldspar, are treated by mineral acids, preferably nitric acid. It is advantageous to carry out the operation in two phases, by first using an amount of acid sufficient to dissolve only the potash in the mineral and treating the residue from this solution with the amount of nitric acid, required for the dissolution of the aluminous compounds. (Fr. Pat. 529,570. Norsk Hydro-Elektrisk Kvaelestofaktieselskab, Christiania, Norway.)

A New Hypochlorite Bleach—A mixture of chlorine and air is passed over a paste consisting of lime and water to which has been added a saturated solution of calcium chloride and calcium hypochlorite. This paste may also contain the products of decomposition of calcium hypochlorite, as well as the soluble salts present in the caustic lime used. The reaction mass is continuously stirred during the chlorination. The resulting paste is filtered and the solid part which is the active product, is dried in a vacuum at a low temperature. The resulting product is characterized by its stability. (Fr. Pat. 530,706. P. Andren.)

Breaking Down Emulsions—A reagent is added to the emulsion which disperses as a colloid in the continuous phase of the emulsion and hence comes automatically into contact with the suspended globules, causing the latter to coalesce. The reagent used is a compound which acts as an emulsifying colloid tending to invert the form of the emulsion, and a second compound capable of dissolving the former and the continuous phase of the emulsion. Good results are obtained, for instance, by means of a reagent composed of about 25 per cent of a soda soap, 10 per cent of water and 65 per cent of oleic acid. This reagent may be prepared so as to render it colloiddally soluble in oil. Likewise good results are obtained from a reagent composed of 4 per cent of calcium oleate dissolved in a mixture of 50 per cent al-

cohol and 50 per cent glycerine to which 1 per cent of gelatine is added as a stabilizer. A reagent answering this description is soluble in water, although it contains hydrophobe colloidal calcium oleate. One practical example of the invention consists in adding 1 per cent by weight of a reagent composed of 40 per cent of water, 35 per cent of free rosin and 25 per cent of soda-roisin soap to a viscous oil-water emulsion, the mixture being stirred to promote the dissolution of the reagent in the emulsion, and centrifuged whereby the water is caused to separate from the oil. (Fr. Pat. 532,148. Sharples Specialty Co., West Chester, Pa.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Antiseptic Soap—An antiseptic and insecticidal compound comprises soap, alkali benzoate and vegetable or mineral tar. In examples, 80 parts of hard or soft soap are mixed with 10 parts of sodium or potassium benzoate and 10 parts of birch tar; or a mixture of 80 parts of fatty acids, 10 parts of benzoic acid and 10 parts of birch tar is saponified in a manner not involving boiling or salting out of the soap. (Br. Pat. 186,078. R. Macpherson, Worthing, Sussex, and W. E. Heys, Bushey, Hertfordshire. Nov. 15, 1922.)

Synthetic Resins—Resinous products are obtained by heating phenols with sulphur in the presence of a base, the amount of base employed being not more than one-fifth equivalent of the phenol; from 2 to 3 atoms of sulphur per molecule of phenol are used and the heating continued until evolution of sulphuretted hydrogen ceases. Catalysts such as halogens or compounds yielding halogens may be added. The products are fusible and soluble in alkalis, alcohol, acetone or benzene, and may be converted into insoluble infusible products by prolonged heat, or heat and pressure, or they may be hardened by treatment with a small amount of formaldehyde or substances yielding it. According to examples, the following parent materials are employed: phenol, sulphur, and potassium hydrosulphide; o-cresol, sulphur and potassium carbonate; phenol, tri-cresol, sulphur, aniline and iodine; resorcin or α - or β -naphthol, sulphur and caustic soda; an example of hardening the resin by means of hexamethylene-tetramine is also given. (Br. Pat. 186,106. T. M. Hickman, Wolverhampton. Nov. 15, 1922.)

Chrome Alum—Chrome alum crystals are prepared by adding to green chrome alum solution small quantities of potassium bichromate, sulphuric acid and sulphurous acid, when the violet chrome alum is immediately produced and is readily crystallized. The quantity of potassium bichromate is not sufficient to oxidize any iron present and the sulphuric acid is equivalent to the potas-

sium of the bichromate. In an example, ferrochromium is dissolved in sulphuric acid, and about half of the ferrous sulphate is removed by crystallization. The ferrous sulphate is separated in a centrifugal machine and the necessary quantity of potassium sulphate is then added. The green solution is then treated as above described to obtain chrome alum crystals.

A second specification covers a modified process involving the intermediate production of chromium hydroxide. Ferrochromium is dissolved in sulphuric or hydrochloric acid, and an alkali hydrate or carbonate or an alkaline earth hydrate is added in quantity sufficient to precipitate the chromium as hydroxide free from iron. The precipitate is washed and dissolved in sulphuric acid, and potassium sulphate is then added to produce chrome alum. (Br. Pat. 187,231 and 187,232; not yet accepted. Chemische Fabrik in Billwarder vorm. Hell and Sthamer Akt.-Ges. and P. Hasenclever, Hamburg. Dec. 13, 1922.)

Evaporation—In evaporating liquids in multiple-effect apparatus particularly of the kind described in specification 180,963 in which the liquid is fed in parallel to the effects, the liquid is passed in series through a number of multiple-effect plants, the temperature ranges of which coincide or overlap substantially. In concentrating brine or other liquid the boiling point of which rises on evaporation, the first effects of each plant are preferably supplied with steam from the same source and the last effects are connected to the same condenser, and the number of effects in each succeeding plant is progressively diminished. In evaporating cane or beet sugar solutions, the concentration obtained in the last plant may be such that crystals separate in the effects of this plant, or crystallization may be effected outside the plant in crystallizing vessels which may be supported on wheeled devices or in heated pans in which slow evaporation takes place. When the concentrated liquid is to be cooled to cause crystallization or for other purposes, the vessel containing the liquid is connected to the vapor spaces of effects at progressively lower pressures as to cause the liquid to flash off steam and to lower the temperature in stages. The method of cooling the concentrate and recovering the heat for use in the evaporating process may be used in plant in which the multiple-effect apparatus is replaced by apparatus of the kind described in specification 12462/11, in which the vapors evolved on evaporation are compressed and used as the heating agent. In concentrating impure liquids such as sea water, which at one stage of the concentration will deposit impurities, such as calcium sulphate, etc., on cooling, the cooling may be effected by flashing-off vapors from the solution by connection with effects of lower pressure, during the passage of the solution from one evaporating plant to the next. The solution may be preheated before passage into the

next plant by heat-exchange with the solution from the first plant. According to one provisional specification the control device described in specification 180,963 for controlling the passage of vapor from one effect to another may be used also to control the flow of liquid from the source of supply into the effect. (Br. Pat. 187,260. T. Rigby, Westminster. Dec. 13, 1922.)

Fertilizers—Manures containing an ammonium compound or compounds and a secondary fertilizing agent or agents, such as a salt of potassium or a phosphate, are obtained by reaction between gases containing ammonia and the semi-dry product obtained by treating with acid a naturally occurring material that contains the secondary fertilizing agent or agents, but which is free, or almost free, from lime and is not generally regarded as a manure in itself. Thus clay containing a compound of potassium may be treated with sulphuric acid, if desired after drying and pulverizing, in sufficient amount to constitute a semi-dry mass, which is brought into contact with gases containing ammonia.

The product contains the oxides of iron and aluminum, and ammonium sulphate, together with a soluble compound of potassium, the content of which may be increased by direct addition of potassium salts. Other examples of naturally occurring materials suitable for use in the process are alunite and shales containing iron, aluminum, sulphur and potash, with or without phosphorus. Alunite may be calcined and used without any addition of acid. Instead of sulphuric acid there may be used sulphur dioxide or trioxide, hydrochloric or phosphoric acid, spent pickling liquor, or acid salts, or mixtures of any of these. Where phosphoric acid is used, gases containing ammonia may be treated in a heated condition; if, however, the absorption is allowed to proceed for a long time at atmospheric temperature, material containing triammonium phosphate is obtained. The products may be lixiviated to remove the soluble salts, or they may be heated to about 400 deg. C., when about 50 per cent of the ammonia present is evolved, leaving a residue still suitable for use as a fertilizer or for re-use in the process. (Br. Pat. 187,251. E. L. Pease, Hurworth Moor. Dec. 13, 1922.)

Motor Fuel—A fuel for internal-combustion engines comprises a mixture of ether, alcohol and a volatile vegetable oil such as rosin oil or oil of turpentine, with or without a small amount of caustic soda. The preferred proportions are 36.75 parts by volume of alcohol, 62 parts of ether, 1 part of rosin oil and 0.25 part of a saturated solution of caustic soda in alcohol. "Commercial" ether may be used in slightly larger proportion. The fuel is miscible with lubricating oil and thus is suitable for two-stroke engines. (Br. Pat. 187,326. H. R. Giles, London. Dec. 13, 1922.)

Motor Fuel—The method of producing an alcohol fuel described in specification 178,498 and consisting in agitating, under pressure, a mixture of commercial alcohol and acetone with calcium carbide, is applied to monohydric alcohols, other than commercial alcohol, such as amyl, butyl and propyl alcohols. The alcohols preferably contain up to 10 per cent of water, and 5 to 40 per cent or more of acetone is added. The pressure is preferably from 10 to 40 lb. per sq.in., depending on the amount of acetylene to be absorbed. The lime in solution or suspension in fuels of this type is removed by chemical means, such as by treating the fuel with ammonia and passing in carbon dioxide, or by the addition of powdered ammonium carbonate. A suitable lubricant may be added. (Br. Pat. 187,335. S. W. Blake, Oudtshoorn, South Africa. Dec. 13, 1922.)

Coal Carbonization—A mixture of powdered caking and non-caking coal is carbonized at a temperature of between 600 and 760 deg. C., whereby expansion and the development of a highly cellular structure is avoided and a bright and hard coke is obtained. Coke breeze may be substituted for a portion of the non-caking coal, or the latter may be replaced by a caking coal the caking properties of which have been destroyed by a preliminary heat treatment of between 100 and 350 deg. C. (Br. Pat. 187,336. J. Roberts, Glamorgan. Dec. 13, 1922.)

Synthetic Resins—Synthetic resins are produced by subjecting an aldehyde or its products of condensation or polymerization to the continued action of a mineral acid or acid salt, in the presence of a solvent if desired and preferably at a raised temperature. The products may then be hardened by prolonged heating at a high temperature, with or without the separation of the excess of acid. Further hardening may be effected by fusion with metal oxide or esterification with an alcohol, such as glycerine, before or after the heat-treatment; subsequent oxidation bleaches the products and makes them soluble in borax. The synthetic resins, when dissolved in the usual resin solvents, can be used as lacquers, polishes and finishes; and, being of low melting point, they can be added to other resins to render them more fusible. According to the examples, (1) acetaldehyde and sulphuric acid are heated together at 40 deg. C. for some hours and then raised to 100 deg. C. until a sample sets on cooling to a tough mass; the product is maintained in the molten condition, about 150 deg. C., for a long time, and sets when cold to a hard resin; (2) crotonic aldehyde is heated with hydrochloric acid, or with sulphuric acid in the presence of acetic acid as a solvent, or acetaldehyde is heated with sodium bisulphate solution, and the products in each case are further treated as in example (1). (Br. Pat. 187,619; not yet accepted. Consortium für Elektrochemische Industrie Ges., Munich. Dec. 13, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Muscle Shoals Disposal Discussed Anew

Hearings on Resolution to Create Revolving Fund for Government
Fertilizer Business Renews Storm Over
Nitrate Plant Sale

REVIVAL of the controversy over the disposition of the government's hydro-electric development and nitrate plants at Muscle Shoals has come in Congress as the result of hearings by the House Committee on Agriculture on the resolution to create a revolving fund of \$10,000,000 for the purchase by the federal government of stocks of nitrate of soda and sale at cost to farmers. This resolution has passed the Senate.

While the resolution has no direct connection with the Muscle Shoals proposition, the latter were brought into the discussion because of the fertilizer portion of the Ford offer.

Advocates of acceptance of the Ford offer for the properties have come into conflict with those who contend that this bid is not acceptable, and with others who are urging a government corporation to operate both the power project and the chemical works.

The sharpest conflict over the Muscle Shoals project was not before the House committee, but was inspired by its hearings. Bernard Baruch, former chairman of the War Industries Board, appeared before the committee among other witnesses, advocating adoption of the resolution by the House. Subsequently Mr. Baruch sent a letter to Gray Silver, representing the American Farm Bureau Federation, in which he recommended acceptance of the Ford offer for Muscle Shoals because of the clause which would specify production of fixed nitrogen. This letter was made public and caused a heated reply from Senator Norris, author of a bill to establish a government corporation, in which he charged that Mr. Silver represented Mr. Ford rather than the farmers of the country. Mr. Silver subsequently called upon the Nebraska Senator for a retraction and asked an investigation by the directors of the Farm Bureau.

Baruch Supports Ford

The conclusions given in Mr. Baruch's letter are based on a survey of Leland L. Summers, an engineer employed by Mr. Baruch.

Mr. Summers considered every possible method of disposing of the plant, weighing the merits of each. Mr. Baruch limited his suggestions to the following three:

1. Government development. Except as a last resort, I am opposed to

this on account of its inherent disadvantages.

2. Combination of industry either with government co-operation or independently.

3. The Ford development. This apparently is the only offer that has come forward so far from a private source promising development along commercial lines. If no more advantageous offer should be made, the arguments against awarding the contract to Henry Ford would not be convincing.

Urges Modification

"Without commenting upon the terms of the contract or considering the adequacy of the price, there are certain modifications or clarifications that should be made," says Mr. Baruch. "All doubt in regard to Mr. Ford's personal liability should be removed.

"The most important thing that ought to be clarified is the following: That Mr. Ford undertakes to make 40,000 tons of fixed nitrogen per year, and if he does not make it the property is to revert to the government. After all, it is the fixing of the nitrogen that is the crux of the whole contract. I am quite sure that the contract means to cover this point, but it should be made clear.

"However great the pecuniary rewards might be to Mr. Ford, or to anyone else who will undertake it, there will be added a contribution of almost inestimable value to the future of American agriculture and the safety of America in time of war."

Work on Dam Progresses

The concrete work in the foundation in the cofferdam across the north channel at Muscle Shoals has been finished and the cofferdam is being torn out. Brigadier-General Harry Taylor has returned from a visit to the work and reports that the higher water in the Tennessee River in no way has delayed the work thus far. During December, 41,491 yd. of concrete was put in, he said. The latest figures available when he left Muscle Shoals were those from Jan. 1 to 20, during which period 24,279 yd. of concrete was put in.

General Taylor states that the work is being carried well within the estimates and that it can go forward at the maximum rate if the Senate approves the appropriations allowed by the House. The House voted \$6,998,800 in cash and authorized \$10,501,200 for continuing contracts. This amount

Nitrate May Be Sold to Farmers at Cost

The resolution authorizing the President to purchase nitrate for sale to farmers at cost and creating a \$10,000,000 revolving fund for this purpose has been ordered reported favorably by the House Committee on Agriculture. It has been adopted by the Senate. This is one of the measures advocated by the farm bloc in Congress.

By the terms of the resolution, the President is "authorized and directed to procure, or aid in procuring, such stocks of nitrate of soda as he may determine to be necessary and find available for increasing agricultural production during the calendar year 1923, and to dispose of the same at cost, payable in advance." The President is authorized to make such regulations and to use such means and agencies of the government as he may deem best in carrying out the provisions of the resolution.

Canada May Be Arsenic Source

In the calculation of supplies of arsenic which might be secured from abroad, the possibilities of an expanded production in Canada seem to have been overlooked. Advices reaching Washington are to the effect that Canadian exports can be materially increased. Steps are now being taken by government statisticians to ascertain the approximate possible increase of the Canadian output.

will complete the dam and the power house and will permit of the installation of eight power units. Practically all of the waterwheel machinery for four of these units now is on the ground and can be installed immediately when they are ready for it.

New Appropriation Proposed

So that the possibilities of Nitrate Plant No. 1, at Muscle Shoals, in the matter of fertilizer production may be known, Senator Norris, chairman of the Committee on Agriculture, has proposed the following legislation:

"For the improvement of Nitrate Plant No. 1, at Muscle Shoals, Ala., by the installation of new machinery therein, in order that said plant may be utilized for experimental purposes in extracting nitrogen from the air with a view of lessening the cost of explosives in time of war and fertilizers in times of peace, \$2,000,000."

Officials Still Grope for Dye Valuation Basis

Importers and Manufacturers Unable to Agree on Definition of Term "Competitive"—May Use Trade Journal Prices as Authority

Suggestions for regulations regarding the administration of the coal-tar products paragraphs of the 1922 tariff bill have been submitted to the Customs Division of the Treasury Department by the New York appraiser's office, which has been conducting research work on the subject. They have been taken under advisement, with indications that formal regulations will be promulgated before the end of February.

One of the stumbling blocks that has been encountered in framing these regulations is the proper definition of "competitive." The tariff act provides that imported coal-tar intermediates and finished products which are comparable, and thus competitive, with domestic products shall be assessed on American valuation, a considerably higher rate than the United States selling price, which is to be the basis of assessment of non-competitive products. The definition has not been decided by the Treasury Department.

When Is Product Competitive?

It has been determined, broadly, that a coal-tar product of domestic manufacture shall not be considered competitive with a comparable imported product unless "freely offered for sale in the usual course of business." Thus, if a certain color, for instance, is produced in the United States in such limited quantities as to be wholly insufficient to supply the demand, it will not be able to command the protection of the higher customs duty against an imported competitor because not "freely offered for sale." It is considered also that certain price factors will be taken into consideration under this part of the proposed regulations in determining the question of competition.

It has been no secret that the work of determining such valuation has been shunned by the Board of Appraisers and customs officials because of the great difficulties in arriving at an equitable basis for determining the American valuation of these products. The several conferences which have been held failed to clarify the situation to any extent. In fact matters have virtually reached an impasse.

Daily Source of Trouble

Instances of the chaotic situation which has been reached are an almost daily occurrence in the fine chemical trade. An importer desires information on a coming shipment of acetanilide. He calls the proper official and asks the duty on it. He is told 7c. per pound specific and 55 per cent ad valorem on the basis of American valuation. So far, so good. He then asks for purposes of computing the actual duty in dollars and cents what the American valuation is. He can get no answer, for

Daily Customs Reports on Dyes

So that current information may be available as to the volume of dye imports, the Department of Commerce has stationed a man in the New York Custom House to make a special study of these imports and furnish information from day to day as to the character of the receipts of foreign dyes.

there is none. The effect upon trade is apparent.

May Use Journal Prices

A proposal has recently been made to the effect that for purposes of American valuation of these items the average prices are reported in the three leading chemical and drug trade journals be accepted as the American value of the item in question. The trade has welcomed this suggestion as a way out of a very troublesome and confusing situation. It is proposed that the appraisers accept the average prices of drugs and chemicals, as quoted by the recognized authorities among the trade publications, and assess the duties upon this average. This would simplify and clarify the work of the appraisers as well as the actual business of importing such materials as come under the American valuation plan in the tariff law. Representative interests in the trade who have been interviewed refused to make any comment on the scheme in the absence of any definite information regarding the attitude of officials at Washington.

Government Will Sell Nitrate in Small Lots for Farmers

Formal reannouncement has been made of the sale of 28,000 short tons of surplus nitrate of soda held by the government at the Old Hickory Ordnance Depot at Jacksonville, Tenn. This material is being offered for sale in lots of 20 short tons or more. Bids will be received at the Army Building 39 Whitehall St., New York, until noon, Feb. 15.

This surplus nitrate previously had been offered for sale in lots of 100 tons or more. The offer was withdrawn, however, after several Senators and Representatives had petitioned the Secretary of War to lower the minimum limit so that farmers could purchase the material for fertilizer purposes.

Leather Chemists to Meet at White Sulphur Springs

The American Leather Chemists Association will hold its twentieth annual convention at the Greenbrier, White Sulphur Springs, W. Va., on June 7, 8 and 9. Full information concerning details of the meetings, hotel rates and transportation may be obtained by addressing H. C. Reed, secretary, 22 East 16th St., New York City.

Alien Property Bill Revised

Winslow Bill Now Provides Return of Confiscated Alien Property Valued at Less Than \$10,000

Revision of the Winslow bill to return certain classes of trusts held by the Alien Property Custodian has been directed by the House Committee on Interstate and Foreign Commerce, this duty being referred to a subcommittee composed of Representatives Graham of Illinois, Newton of Minnesota and Johnson of Mississippi.

Change in sentiment came among members of the committee when the State Department, aroused by reports that the majority of the committee inclined to go further than recommended by Colonel Thomas W. Miller, Alien Property Custodian, who urged return of all trusts valued at \$10,000 or less, and \$10,000 of the value of larger trusts, and voiced disapproval of lowering the holdings to a point which might not secure payment of American citizens' claims against Germany. Some members of the committee previously had favored return of 50 per cent of the value of all trusts over \$10,000.

Will Return Smaller Trusts

By vote of the committee, the subcommittee was instructed to redraft a bill providing for return only of those trusts valued at \$10,000 or less which are not involved in litigation. The question of what shall be done about patents was reserved for a later vote. Indications are that patents and trademarks will be excepted from the terms of the bill. If this were done, questions affecting the Chemical Foundation and certain patents used by the War Department and Navy Department would be deferred.

There are 28,144 trusts now held by the Alien Property Custodian valued at \$10,000 or less, and to return these would involve \$22,122,002, which would leave a balance on 2,224 larger trusts of \$296,236,899, according to testimony of Colonel Miller.

Forest Products Chemicals Exhibit to Feature Paper Show

In connection with the Paper Industries Exposition, which is to be held in the Grand Central Palace, New York, during the week of April 9, the management has decided to install a booth devoted to dendrochemistry, wherein will be exhibited all of the forest products chemicals which may be produced in the working of the forest for the paper industry. This exhibit is to be purely educational in character and it is hoped to get representative exhibits which will demonstrate to visitors the possibility of profit from the utilization of the chemical byproducts of the forest.

A general request for material for this exhibit has been broadcast. The display will be purely educational, so that no advertising of individual companies or persons will be permissible, except the acknowledgment card giving the names of those who furnish exhibits.

Gas Explosion Wrecks Springfield Plant

Purification Building of Gas Light Company Explodes, Killing Three and Causing Heavy Property Loss

An explosion of the gas-purifying plant of the Springfield Gas Light Co., Springfield, Mass., resulted in three deaths, scores of injuries and property loss running into several hundred thousands of dollars. For the most part, the brunt of the blow fell on business buildings, but in one section of the river front district, in which the explosion occurred, a residential district of tenements and flats, houses were made uninhabitable. Shattered windows, roofs, and in some cases walls that collapsed with the concussion, caused half a hundred families to vacate their homes.

Cause Unknown

Explanation of the explosion was lacking. Officially, the Gas Light Co. said the cause was undetermined. Arthur S. Hall, works manager and superintendent, said he could account for it only on the theory that a slow leak of gas had caused an accumulation under the roof, and that this gas pocket became ignited in some way. He asserted that the machinery, which constituted most of the plant, was virtually intact, and that the damage practically was limited to roof and walls.

The purifying building is about 120 ft. long, half as wide and divided into two sections. That to the east was three ordinary stories high, that to the west about half a story lower. The explosion occurred in the eastern section. The western section suffered little more than did some buildings half a mile away, and to the north the main gas-making plant lost only its windows, which were shaken out by the blast.

The section that was the scene of the explosion was wrecked, but not entirely. The walls went out and the roof went up, but the machinery that they housed can be replaced and repaired.

Gas and Fuel Section of A.C.S. Plans Motor Fuel Symposium

In accordance with a resolution passed at the Pittsburgh meeting of the American Chemical Society the officers of the Gas and Fuel Section are arranging a second sectional meeting for the New Haven meeting. The section program will consist of papers on gas and fuel chemistry and a symposium on motor fuels, held jointly with the Petroleum Division. Under the rules of the society, papers presented at the meeting must be presented by members and must be listed in the final program. In order that they may be so listed the title and an abstract of the paper, preferably about 100 words, must be in the hands of the secretary of the section not later than March 8. The titles and abstracts of articles should be sent to R. S. McBride, 617 Colorado Building, Washington, D. C.

Cresol May Be Placed on Free List

Classification experts of the Treasury Department have prepared a ruling, which probably will be promulgated as a Treasury decision, that cresol shall be admitted without payment of duty under the tariff act. If this ruling is confirmed, other tar distillates with distillation characteristics similar to those of cresol will also be entitled to entry under the free list.

Paragraph 27 provides that all tar distillates yielding 5 per cent or more tar acids below 190 deg. C. or yielding 75 per cent or more tar acids in the portion distilling below 215 deg. C. shall be dutiable. Paragraph 1549 provides for duty-free importation of tar distillates which yield in the portion distilling below 190 deg. C. less than 5 per cent tar acids, but makes no reference to distillation at 215 deg. C. Cresol does not yield 5 per cent tar acids below 190 deg. C. but does give more than 75 per cent below 215 deg. C. It thus falls under both paragraphs but since paragraph 27 permits alternate tests, while paragraph 1549 provides a single requirement which is met by cresol, it has been held that cresol should be entitled to classification under the latter paragraph.

Canadian Paper Mills Plan Expansion

Plans have been perfected or are rapidly maturing for considerable expansion among the paper mills in the vicinity of St. John, N. B., involving a total investment of many millions of dollars.

The construction of a large addition to the plant of the St. George Pulp Co., Ltd., St. George, to provide extensive increase in capacity is planned and will probably cost more than \$200,000.

The Nashwaak Pulp & Paper Co., Ltd., will proceed with the construction of an addition to its St. John pulp mill, designed to increase the capacity of sulphate pulp approximately 50 per cent during the present year.

The Bathurst Co., Ltd., has construction under way and will push to completion a new mill at Bathurst, to have a maximum capacity of 20,000 tons of newsprint and 30,000 tons of sulphate pulp per annum.

The International Paper Co., New York, is projecting a large mill in the Grand Falls district, in connection with an important hydro-electric development.

The Snowball Co., Ltd., is arranging to operate its mill at Chatham at full capacity, and a number of improvements and extensions will be made.

The Fraser Companies, Ltd., is planning for the construction of a large new paper mill on the St. John River, vicinity of Grand Falls, to include a complete sulphate pulp mill; the last noted company also has tentative plans under consideration for enlargements in its present paper mill at Edmunston.

Gathmann Solvent Recovery Process Suit Settled

Holder of Patent Rights Loses Suit Against Navy Department

There was no contract between the Navy Department and Louis Gathmann whereby the government was bound to use his process for drying smokeless powder and recovery of the solvent, according to a decision of the United States Supreme Court affirming the action of the Court of Claims in dismissing a claim of \$236,750 filed against the government by Olga Gathmann Foley, administratrix.

Furthermore, according to the Supreme Court decision, there was no distinctive feature of the Gathmann process which entitled it to patent.

By letters exchanged between Gathmann and the Ordnance Bureau of the Navy Department, the latter, in 1904, agreed to install apparatus at Indian Head, Md., for experiment with Gathmann's process and to pay a royalty of 1 cent per pound on all powder thus dried if the method proved satisfactory. After several months Gathmann was notified that the experiment had not proved satisfactory. The administratrix of his estate filed a claim, asserting that the process had been used and that the letters established a contract. The Court of Claims and the Supreme Court held that the letters constituted an option, not a contract.

New Cellulose Division of A.C.S. Seeks Support

The Cellulose Division of the American Chemical Society has recently been authorized as a permanent division of the society and wishes to enroll as members in the division all those who are interested in cellulose chemistry either from a scientific or practical standpoint. All members of the American Chemical Society wishing to become members of this division are requested to send their names, business connections and one dollar dues to the secretary, L. F. Hawley, Forest Products Laboratory, Madison, Wis.

Eyesight Conservation Council Appoints Directors

Election of Secretary James J. Davis of the U. S. Department of Labor and of Prof. F. C. Caldwell of the department of electrical engineering, Ohio State University, as directors of the Eyesight Conservation Council of America is announced by L. W. Wallace, president of the Council, the annual meeting of which was held in New York City, Feb. 6.

Secretary Davis and Professor Caldwell will act with leading engineers, educators, state and federal officials, economists and civic leaders in carrying on a nationwide plan to conserve vision in industry and education. The movement is being directed from New York by Guy A. Henry, general director of the Council.

December Chemical Exports Decline

Show Improvement Over Same Period Last Year, However

While there was a decrease of nearly half a million dollars in the value of chemicals and allied products exported during December as compared with the value of exports in November, exports still ranged well above those of December, 1921. The decline in December of 1922 did not apply to the same extent to chemicals proper. In that case the value of the exports in December was only about \$200,000 under those of November.

In December, 1922, there were substantial increases in acid exports, the increase being particularly notable in boric acid, where the amount exported increased from 82,506 lb. in November to 503,263 lb. in December. Exports of copper sulphate more than doubled in December, as compared with November, as did the value of exports of calcium carbide. Exports of formaldehyde fell off, as did those of cyanide of soda and water glass and caustic soda. There were substantial increases in exports of borax and of soda ash.

Exports of pigments, paints and varnishes continued at about the November rate, which is substantially above the rate of export during the corresponding period of 1921. The value of exports of fertilizers dropped about \$300,000 as compared with November, but were in excess of the value of exports in December of 1921. Exports of sulphate of ammonia aggregated 10,716 tons, as compared with 9,220 tons in November. Exports of explosives increased decidedly. The figures of those of the Bureau of Foreign and Domestic Commerce.

Comparative figures showing the volume of exports of some of the chemicals of less importance are as follows:

	Dec., 1921 Lb.	Dec., 1922 Lb.
Carbolic acid	7,511	93,461
Magnesium sulphate		157,167
Chlorate of potash	78,399	48,431
Thorium nitrate		96
Zinc chloride		875
Carbon and lamp black		787,196
Litharge	74,619	193,184

Industrial Situation in the Ruhr Being Studied by Government

A study of the effect on world chemical markets by the occupation of German territory by the French is being made by government specialists. Unofficial reports are to the effect that most of the chemical plants still are in operation, but cable advices to the Department of Commerce on Feb. 1 indicated that the continuance of operations is highly uncertain. The entire industrial situation in the occupied region was described as critical.

A large number of chemical plants in unoccupied Germany are affected by the situation, since they depended on

the Ruhr for coal tar and intermediates. While it is believed that foreign orders will be sent forward through France as long as stocks last or output can be maintained, the matter of transportation even by that route is uncertain.

The Commerce Department's cable also contained the information that Germany had discontinued deliveries of reparation dyes to France and to Belgium, but that deliveries to England

and to the United States were continuing.

At the State Department no comment was forthcoming on the dye situation, but it is known that an active cable correspondence is being conducted and there is reason to believe that the negotiations in connection with the application of dye deliveries on the account of the United States against Germany for costs of the Rhine army are in a precarious state.

Personal

Prof. VICTOR ANDRES BELAUNDE, of the University of St. Marcos, Lima, Peru, is in New York City, and can be reached through the Peruvian Legation. He is editor of the *Mercurio Peruano*.

Dr. LEONARD H. CRETCHER has been appointed to the research staff of the Mellon Institute, Pittsburgh, Pa., to head an industrial fellowship devoted to the synthesis of chemiotherapeutic products. Dr. Cretcher is a graduate of the University of Michigan, studied one year in Germany and afterward took his Doctor's degree at Yale University. During the war he was commissioned a Captain in the Chemical Warfare Service. Later, at the close of the war, he became connected with the research department of the National Aniline & Chemical Co., subsequently being placed in charge of one of the large dye works of the company in the Buffalo, N. Y., district.

B. H. DELONG, metallurgist of the Carpenter Steel Co., Reading Pa., presented a paper on "The Manufacture of Alloy Steels" before the Washington Chapter of the American Society for Steel Treating at its monthly meeting on Jan. 26.

W. H. HENDRICKS, general sales engineer of the N. J. Zinc Co., New York, was the speaker at a meeting of the N. E. Paint and Varnish Production Club, Jan. 18. He discussed the history of lithopone from the inception of the industry to the present-day production. He also answered a number of questions concerning lithopone and zinc oxide.

THOMAS J. KEENAN, well known to the paper industry through his long years of work with the Technical Association of the Pulp and Paper Industry and as editor of *Paper*, has retired from that editorship. He will devote his time for the present to the coming Paper Industries Exposition which will be held in New York during the week of April 9.

W. F. LANTZ has been appointed chief chemist at the plant of the Bethlehem Steel Co., Bethlehem, Pa., to succeed A. D. SHANKLAND, who has been appointed metallurgical inspector at the No. 1 and No. 2 mills.

GEORGE D. PAINE, formerly of Chicago but more recently with Cook & Swan, N. Y., has been transferred to the latter company's office at 128 N. Wells St., Chicago, as manager.

DONALD K. PATTILLO has severed his connection as chemical engineer with the Hamersley Manufacturing Co., of Garfield, N. J., to accept a position as research chemical engineer with the Western Electric Co., of Chicago, Ill.

O. D. STREET, well known for the last 10 years as general manager of distribution of the Western Electric Co., has been elected a vice-president of the McGraw-Hill Co. He will have executive charge of *Electrical World*, *Electrical Merchandising*, *Journal of Electricity and Western Industry*, *Industrial Engineer*, *Electric Railway Journal* and *Bus Transportation*.

Obituary

GEORGE ELLIOT BROWN, vice-president, Swan & Finch Co., New York, refiners and dealers in oils, died suddenly on Jan. 24 from pneumonia, after a brief illness at his home in Norwalk, Conn. He was 55 years of age.

WILLIAM P. WAUGH, consulting engineer for the H. H. Robertson Co., Pittsburgh, Pa., and well known through his development of skylights and the solution of ventilation problems for many industrial plants and public buildings, died at his home at Sewickley, Pa., on Jan. 15. Mr. Waugh was born in Hedrick, Iowa, and attended Iowa State College, at Ames, Iowa. During Mr. Waugh's association with the H. H. Robertson Co. his skylights were developed to their present state of perfection. Some of his most notable installations are those on the Cadillac, Packard and Dodge Motor company plants in Detroit, the Indianapolis Union Station, and the Centennial Memorial Building at Springfield, Ill. During this period he also developed a double glazed skylight that is widely used on paper mills and in textile plants where drippage must be constantly guarded against.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Domestic Business Conditions Continue Almost Uniformly Favorable

Seasonal Declines Expected in January Fail to Appear—Outlook Is Particularly Bright—Chemical Prices Are Mounting, Although General Commodity Prices Are Relatively Stable

JANUARY almost always shows some let-up in industrial activity after the first rush of contract making and inventory re-stocking has subsided. This year, however, the month has been characterized by well-sustained business in practically all lines, and in many instances there have been increases over the preceding month. The Department of Commerce reports that figures which became available during the week ended Jan. 22, 1923, have confirmed this industrial improvement. Particularly has the better transportation situation favorably affected the shipment and distribution of many commodities. Retail sales have been of record proportions and current reports indicate that sales have been well maintained during January. General price levels have remained relatively stable, although increases in some groups and decreases

in others have tended to bring these groups more in line with other commodities.

Chemical prices have shown a very sharp rise since the first of October and especially during January was the increase most marked. The total gain, as recorded by *Chem. & Met.*'s index of chemical prices, amounted to about 30 points. Almost half of this gain occurred during January, as will be seen from Fig. 1.

The Trend of Production

The index of production in the basic industries compiled by the Federal Reserve Board has also been rising rapidly since last August. A very slight recession was shown in December, although, on the whole, production was maintained at a level near the peak of 1920. The output of pig iron and coal

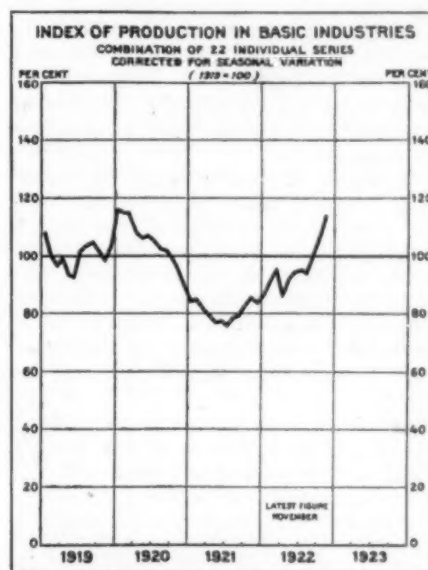


FIG. 2—FEDERAL RESERVE BOARD'S INDEX OF PRODUCTION

continued to increase, but the production in certain industries, notably textiles, has shown some declines. Consumption of cotton by textile mills in December totaled 527,945 bales, or about 50,000 bales less than the very high record made in November.

Petroleum production in the week ended Jan. 27 has been estimated by the American Petroleum Institute to have amounted to 1,755,300 bbl. This is the highest rate of production ever recorded and is an increase of 18,400 bbl. over the preceding week.

Copper production in December reached 103,845,000 lb., the largest for any month since 1920. This compares with 18,595,000 lb. in December, 1921.

Current production figures in the heavy chemical industry are not avail-

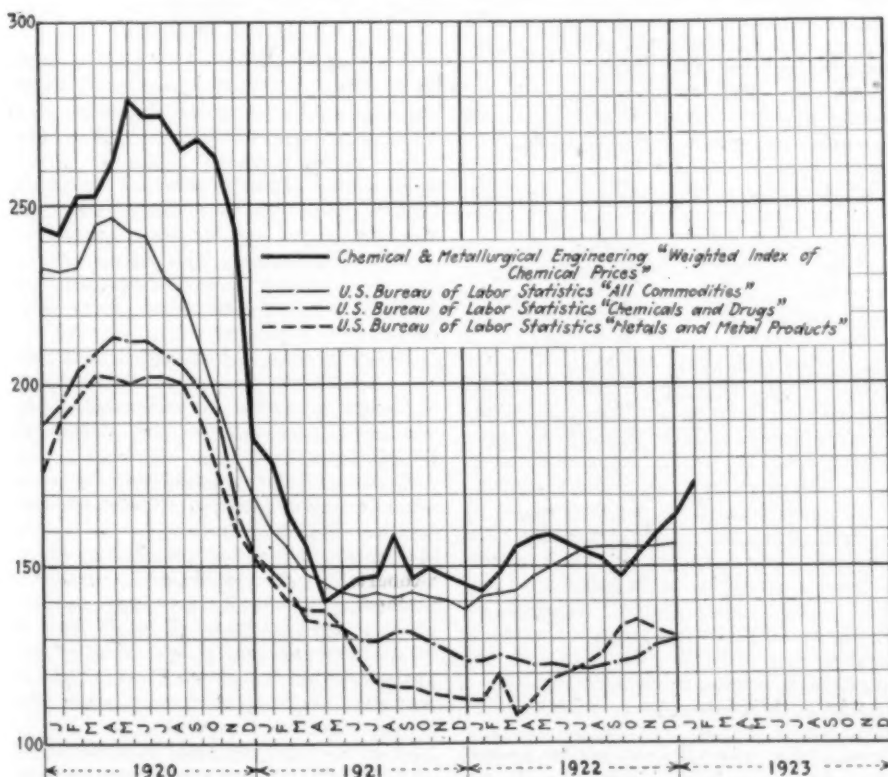


FIG. 1—WHOLESALE PRICES FOR CHEMICAL, METALLURGICAL AND ALLIED PRODUCTS

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

Last week	175.08
February, 1922	148
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

Included in this index are acetic, citric, hydrochloric, nitric, and sulphuric acids, ethyl and methyl alcohols, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, salt cake, soda ash, sulphur, benzene, aniline, and cottonseed and linseed oils.

able, but the manufacturers of alkalis report that their plants are now operating at practically maximum capacity. In the dye and fine chemical industries the improvement has been less general, but there is, nevertheless, substantial evidence of better business prospects.

Employment in December

The Bureau of Labor Statistics, in its reports on the volume of employment during December, states that 3,294 representative establishments in 43 manufacturing industries employed 1,587,708 employees, as compared with 1,551,080 in November. There was an increase of 2.4 per cent in the number of employees and of 3 per cent in the total payrolls.

Increases in the number of employees in December, 1922, as compared with the number of employees in identical establishments in November, were shown in 33 of the 43 industries, with decreases in the remaining 10 industries. Pottery, owing to the resumption of work after the settlement of the recent strike, shows the greatest increase, 29.9

TABLE I—INDEX NUMBERS FOR WHOLESALE PRICES IN NOVEMBER AND DECEMBER, 1922

	1921 Decem- ber	1922 Novem- ber	1922 Decem- ber
Price Index Numbers			
Wholesale prices:			
Department of Labor—			
Farm products.....	120	143	145
Food, etc.....	136	143	144
Clothing and clothing.....	180	192	194
Fuel and lighting.....	199	218	216
Metals and metal			
products.....	113	133	131
Building material.....	158	185	185
Chemicals and drugs.....	127	127	130
Housefurnishing			
goods.....	178	179	182
Miscellaneous.....	121	122	122
All commodities.....	140	156	156
Dun's (first of month).....	136	153	153
Retail price, food.....	150	145	147

per cent. Fertilizer plants, following a seasonal let-up in December, showed decreased employment of 11.4 per cent.

In 40 chemical works employing 14,025 workers in November there was an increase of 0.2 per cent in number on payroll and of 3.8 in amount of payroll. Twenty-eight petroleum refineries employed 41,903 employees in November and 42,693 in December, an increase of 1.9 per cent. Wage increases, however, raised the amount of their payrolls by 6.5 per cent.

Wholesale Prices

The Department of Labor wholesale price index showed no change in December, remaining at 156, the same as in November. Slight increases in farm products, foods, cloth and clothing, chemicals and housefurnishing goods were offset by declines in fuels and metals. Dun's index number also showed no change, while Bradstreet's declined 1 point. The retail food index increased again, reaching 147, the highest for any month of 1922. These index numbers are shown in Table I. The chemical, metallurgical and all commodity indexes are shown graphically on the preceding page (Fig. 1).

Disturbing Influences Result in Higher Prices in New York Chemical Market

Transportation and European Difficulties Have a Tendency to Maintain Strength Throughout the List—Manufacturers Reduce Quotations on Citric Acid—Arsenic Continues in Scant Supply

NEW YORK, Feb. 5, 1923.

THE growing shortage of freight cars has caused a pronounced scarcity of caustic soda and soda ash on the spot market and has also strengthened prices along the entire list. It is expected that the European disturbance will continue to affect German chemicals, and dealers in barium chloride, prussiate of soda, barium carbonate and sal ammoniac have not shown any inclination to sell at low prices.

Manufacturers of citric acid reduced prices to the level of imported material. Bleaching powder has been in very scarce supply at the works and second hands have been getting a premium for spot and prompt shipments. Oxalic acid was somewhat lower among producers. Sulphate of ammonia is quite scarce due to the recent heavy shipments to Japan. The demand for arsenic has again strengthened and resale stocks are rapidly diminishing. Prices for spot goods were materially higher. Caustic potash, carbonate of potash, chlorate and permanganate of potash continue along very firm lines.

Principal Price Changes

Alcohol—There were no important changes during the week. The 95 per cent methanol was quoted at \$1.21@ \$1.23 per gal. in barrels, with 97 per cent at \$1.23@ \$1.25. Denatured 188 proof No. 1 formula held around 38@40c. per gal. in drums.

Arsenic—The lowest price heard for resale stocks ranged around 15½c. per lb. Recent heavy arrivals have been quickly sold.

Bichromate of Soda—The demand is running along moderately active lines with carload quantities quoted at 7½c. per lb. and lesser lots at 7¼@8c. f.o.b. works.

Bleaching Powder—Producers reported a heavily sold up condition at the works and quote the market at 2c. per lb. for large containers. Second hands have been getting up to 2¼c. per lb. for prompt shipment goods in large drums and 2½c. per lb. for export packages. Demand is exceptionally active.

Caustic Soda—The export inquiry is rather quiet, but prices are quite firm, due to the scarcity of spot goods. Domestic material is in very good demand and sales went through at \$3.75 per 100 lb. ex-store. Contracts continue at 2½c. per lb., basis 60 per cent. f.o.b. works, in carload lots.

Citric Acid—Leading producers announced a reduction to a parity with imported goods. Prices range around 49c. for crystals and 50c. per lb. for powdered. Demand is quite steady.

Copperas—Several transactions have been reported at \$21.50 per ton in bar-

rels. Bulk material is somewhat lower at \$16.50 per ton f.o.b. works.

Formaldehyde—Producers continue to quote 16c. per lb. for carload lots f.o.b. works. Second hands were anxious to dispose of stocks and quoted down to 15½c. for 25-bbl. lots.

Lactic Acid—Leading producers report a regular demand from consumers for the various grades. The 44 per cent light was sold at 11c. per lb. in barrels, with 22 per cent light at 5c. per lb.

Nitrite of Soda—Several lots of imported material were on the market at 8¼@8½c. per lb. Domestic producers continue to quote 10@10½c. per lb., f.o.b. works. The general market is irregular.

Salt Cake—The demand is rather steady, with quotations heard around \$25 per ton f.o.b. works for bulk. Spot material is in scarce supply around \$30 per ton.

Soda Ash—Spot material is quite scarce, due to transportation difficulties. Spot goods in single bags were held around \$1.75 per 100 lb., carload lots. Contracts at the works were quoted at \$1.20 per 100 lb., basis 48 per cent, single bags, carload lots.

Sulphate of Ammonia—The lowest quotation heard for prompt shipment ranged around \$3.85 per 100 lb., double bags, f.a.s. New York.

Coal-Tar Products

Aniline Oil—Several fair-sized sales were noted at 16½@17c. per lb. in drums on spot. Quotations in general held quite firm, with producers quoting 16c. per lb. at the works.

Benzene—Manufacturers report a steady call from consumers and quote the 90 per cent at 27c. per gal. in tanks and 32c. in drums. The pure material is quoted at 30c. in tanks and 35c. per gal. in drums. Deliveries have been materially improved.

Beta Naphthol—Although actual sales were not heavy, prices held quite steady at 24@25c. per lb. for technical goods. Sublimed material was quoted at 55@60c. per lb.

Carbazol—The general tone is somewhat irregular, with producers quoting around 75@80c. per lb.

Cresylic Acid—Spot stocks have been practically exhausted and producers announced a heavily sold up condition at the works. Several small lots of 95 and 97 per cent goods were offered among second hands up to \$1.75@ \$1.80 per gal. Actual sales were small, due to the scarcity of supplies.

Phenol—Spot material is quite scarce and dealers are not anxious to dispose of any material under 35c. per lb. Imported good were quoted at 40c. per lb. for shipment.

Better Volume of Business in Chicago District

Revival of Consuming Interest Noted as Imported Chemicals Are Advanced

CHICAGO, Ill., Feb. 1, 1923.

Business in industrial chemicals continued good in this district and all factors reported a satisfactory volume. No great increase was to be noted, but business was steady, with most of it from consumers who were buying for their immediate or near future requirements. Prices held firm with only a few advances noted and these were mainly on imported items. The situation abroad is bad for the importer, as he has no assurance that his present stocks can be replaced.

Principal Price Changes

Caustic soda continued to move well in consuming channels, but the spot movement was not good. Ground 76 per cent soda was quoted on spot in ton lots at \$4.25 per 100 lb. and the solid in similar quantities at \$3.50. *Caustic potash* was very firm following the recent advance, and 8c. per lb. for the 88-92 per cent material was the best offer noted. *Soda ash* moved well and was unchanged at \$2.25 per 100 lb. for material in cooerage.

Potash alum was in good demand and only moderate lots were available for spot delivery. The iron-free lump was quoted at 4½@5c. per lb. and the powder at 5½@6c. Small sales of *ammonium carbonate* were reported with 9c. per lb. the best price named. *Ammonium chloride* was firm with a good demand reported. The white granular material was quoted at 8@8½c. per lb., with slightly better figures named on material for shipment from the East. *Barium compounds* were steady and unchanged in price. *Barium chloride* was offered in small quantities at \$110 per ton and the carbonate at \$90. *White arsenic* showed no signs of breaking and the small lots available on spot were held at 17c. per lb. *Blue vitriol* was firmer due to the strength of the metal, but it was still possible to purchase material at 6c. per lb. in less than carload lots. *Carbon bisulphide* was unchanged in price with small lots offered for spot delivery at 7½c. per lb. *Carbon tetrachloride* was firm and spot material was held at 10½@11c. per lb. *Formaldehyde* was quiet, but the price held firm at 17c. per lb. in single-barrel lots. Consumers apparently took on heavy supplies when the price was low and will not be in the market again for some time. *Furfural* was unchanged at 25c. per lb. in thousand-pound lots. *Glycerine* was quite firm and 18½c. per lb. for c.p. material in drums was the inside.

The price on *phosphoric anhydride* was reduced to 38c. per lb. in case lots of 1-lb. tins. *Potassium bichromate* was firm and was reported as moving well at 12½@13c. per lb. *Sodium bichromate* was also in good demand and was firm at 8½@9c. per lb. *Potassium cyanide* was slow and the price was

unchanged at 55c. per lb. in single-case lots. *Yellow prussiate of potash* was offered in small or moderate lots at 40c. per lb. One small lot of the *red prussiate* was offered at 85c., but no quantity was available below 90c.

Linseed Oil and Turpentine

Boiled *linseed oil* was quoted higher at 98c. per gal. in single-drum lots at the close of today's market. The material continued to move very slowly to the consuming trade and only small transactions were reported.

Turpentine was lower today and pure gum spirits were quoted in single-drum lots at \$1.50 per gal. Like boiled oil, turpentine was in very poor demand and only very small quantities were moving.

Steel Mills to Operate at Physical Limits

Recent Buying Has Given Momentum to Carry Industry Along Even in a Quiet Market

PITTSBURGH, Feb. 2, 1923.

While there is still a very fair degree of activity in finished steel products in point of tonnage turnover in the open market, the curious buying movement of the past 2 months may be said to be over. In each of these months the independent steel producers as a whole sold much more steel than they shipped.

Practically all the mills are now well sold for the remainder of the present quarter, and some are oversold, while in no important product has the Steel Corporation much unsold tonnage for the half year. Many independents have a good backlog of business for second quarter. At the beginning of December, on the contrary, some mills did not have enough business to carry them through the month.

The plain outlook now is that the steel mills will operate substantially at the physical limit to about July 1. The physical limit will probably be made by labor supply rather than any other factor. The mills have had an active market for 2 months and have acquired what is sometimes called "momentum" to carry them along for several months during a relatively quiet market. This is not, however, a momentum that gradually yields to a decelerating influence. Rather it indicates a continuance of the pace of production. That is, if a mill is sold up fully for 2 months and enters business during 5 months at three-fifths of its current shipments, it rounds out the 5 months with its order book liquidated.

Price Advances

The old 2c. price on merchant steel bars may now be said to have disappeared entirely. It remains in the reckoning only in that the Steel Corporation does not seem to have made an "official" advance, though it has sold some tonnage at 2.10c. and would not promise an early delivery at 2c. if it sold at that

price at all. Shapes and plates had previously advanced from 2c. to 2.10c., as already reported. News has leaked out that about Jan. 19 the American Steel & Wire Co. advanced its price on plain wire from 2.45c. to 2.55c. The company has not advanced nails from its \$2.70 level. Its prices are not readily ascertained, as it is not usually a seller, having a large order book. Early in January independents had advanced plain wire to 2.55c. and nails to \$2.80. They are making sales at the prices without difficulty.

Advances in manufactured steel products continue, reflecting higher costs of hot-rolled material. Chain advanced \$5 a ton early in January. In the past week cold-finished steel bars and ground shafting have advanced \$3 a ton, to 2.65c. and 3.05c. respectively, while spikes are up \$3 a ton on standard size, to 2.90c., and small spikes and boat and barge spikes are up \$5 a ton, to 3.50c. Rivets, instead of advancing, are still reported a trifle weak on the old price of 3c.

The predicted advance in sheets by independents has not occurred, but the market is lined up for an advance, with several mills out of the market, being fully sold for the quarter. Blue annealed is going more frequently at an advance. The market is 2.50@2.60c. on blue annealed, 3.35c. on black, 4.35c. on galvanized and 4.70@5c. on automobile sheets.

Coke and Pig Iron

The recent settlement of coal wage matters for another year may have been an influence in the decrease in tonnage turnover in steel products. It has not yet had much discernible influence in the matter of coal and coke prices, probably because transportation has been poorer in some districts, notably the Pittsburgh district, than in December. Steam coal is off a trifle in both Pittsburgh and Connellsville markets, but is well above the low points seen about the beginning of December. Connellsville furnace coke has not declined at all, being \$8@8.25 for spot or prompt. In other words, the liquidation in coke prices is still to come, but this may be deferred 2 or 3 weeks, on account of the continuance of good demand for coke for heating purposes. Buyers of pig iron evidently expect much lower coke prices and count on the decline having some influence on pig iron prices, for there is no forward buying to speak of, and the markets in practically all districts are dull.

Sales of 20,000 to 25,000 tons of Nova Scotia basic pig iron, high in phosphorus and low in manganese, have been made to Eastern steel works at several dollars a ton below the market for local iron and this will probably have an influence on the Eastern pig iron market. The Pittsburgh valley market has continued quiet, with prices not quotably changed, at \$27.50 for bessemer, \$25@326 for basic and \$27@28 for foundry f.o.b. valley furnaces, freight to Pittsburgh being \$1.77.

Current Prices in the New York Market

FOR CHEMICALS, OILS AND ALLIED PRODUCTS

Although these prices are for the spot market in New York City, a special effort has been made to report the American manufacturer's quotations whenever available. In many instances these are for material f.o.b. works or on a contract basis and these prices are so designated. Quotations on imported and resale stocks are reported when of sufficient importance to have a material effect on the market. Prices quoted in these columns apply to large quantities in original packages.

General Chemicals

Acetic anhydride, 85% drums	lb.	\$0.39 - \$0.41
Acetone, drums	lb.	.21 - .21
Acid, acetic, 28% bbl.	100 lb.	3.25 - 3.50
Acetic, 56% bbl.	100 lb.	6.50 - 6.75
Glacial, 99% carboys	100 lb.	12.00 - 12.50
Boric, crystals, bbl.	lb.	.11 - .11
Boric, powder, bbl.	lb.	.11 - .11
Citric, kegs	lb.	.49 - .50
Formic, 85% bbl.	lb.	.18 - .19
Gallie, tech.	lb.	.45 - .50
Hydrochloric, 18% tanks, 100 lb.	lb.	.80 - 1.00
Hydrofluoric, 52% carboys	lb.	.12 - .12
Lactic, 44% tech., light, bbl.	lb.	.11 - .11
22% tech., light, bbl.	lb.	.05 - .05
Muriatic, 20% tanks, 100 lb.	lb.	1.00 - 1.10
Nitric, 36% carboys	lb.	.04 - .05
Nitric, 42% carboys	lb.	.06 - .06
Oleum, 20% tanks	ton	17.00 - 18.00
Oxalic, crystals, bbl.	lb.	.12 - .13
Phosphoric, 50% carboys	lb.	.08 - .09
Pyrogallie, resublimed	lb.	1.50 - 1.60
Sulphuric, 60% tanks	ton	9.00 - 10.00
Sulphuric, 60% drums	ton	12.00 - 14.00
Sulphuric, 66% tanks	ton	14.50 - 15.00
Sulphuric, 66% drums	ton	19.00 - 20.00
Tannic, U.S.P., bbl.	lb.	.65 - .70
Tannic, tech., bbl.	lb.	.40 - .45
Tartaric, imp. crys., bbl.	lb.	.30 - .31
Tartaric, imp. powd., bbl.	lb.	.31 - .32
Tartaric, domestic, bbl.	lb.	.32 - .32
Tungstic, per lb. of WO ₃	lb.	1.00 - 1.20
Alcohol, butyl, drums	gal.	.18 - .23
Alcohol ethyl (Cologne spirit), bbl.	gal.	4.75 - 4.95
Alcohol, methyl (see Methanol)		
Alcohol, denatured, 188 proof No. 1	gal.	.38 - .40
Alum, ammonia, lump, bbl.	lb.	.03 - .03
Potash, lump, bbl.	lb.	.03 - .03
Chrome, lump, potash, bbl.	lb.	.05 - .05
Aluminum sulphate, com. bags	100 lb.	1.50 - 1.65
Iron free bags	lb.	.02 - .02
Aqua ammonia, 26% drums	lb.	.06 - .07
Ammonia, anhydrous, cyl.	lb.	.30 - .30
Ammonium carbonate, powd. casks, imported	lb.	.09 - .09
Ammonium carbonate, powd. domestic, bbl.	lb.	.13 - .14
Ammonium nitrate, tech. casks	lb.	.10 - .11
Amyl acetate tech. drums	gal.	2.80 - 3.05
Arsenic, white, powd., bbl.	lb.	.15 - .16
Arsenic, red, powd., kegs	lb.	.13 - .13
Barium carbonate, bbl.	ton	75.00 - 77.00
Barium chloride, bbl.	ton	90.00 - 100.00
Barium dioxide, drums	lb.	.18 - .18
Barium nitrate, casks	lb.	.08 - .08
Barium sulphate, bbl.	lb.	.04 - .04
Blanc fixe, dry, bbl.	lb.	.04 - .04
Blanc fixe, pulp, bbl.	ton	45.00 - 55.00
Bleaching powder, f.o.b. wks. drums	100 lb.	2.00 - 2.50
Resale drums	100 lb.	2.50 - 2.75
Borax, bbl.	lb.	.05 - .05
Bromine, cases	lb.	.25 - .27
Calcium acetate, bags	100 lb.	3.50 - 3.60
Calcium carbide, drums	lb.	.04 - .04
Calcium chloride, fused, drums	ton	22.00 - 23.00
Gran. drums	lb.	.01 - .01
Calcium phosphate, mono, bbl.	lb.	.06 - .07
Camphor, cases	lb.	.86 - .88
Carbon bisulphide, drums	lb.	.07 - .07
Carbon tetrachloride, drums	lb.	.09 - .10
Chalk, precip.—domestic, light, bbl.	lb.	.04 - .04
Domestic, heavy, bbl.	lb.	.03 - .03
Imported, light, bbl.	lb.	.04 - .05
Chlorine, liquid, cylinders	lb.	.06 - .06
Chloroform, tech., drums	lb.	.35 - .38
Cobalt oxide, bbl.	lb.	2.10 - 2.25
Copperas, bulk, f.o.b. wks.	ton	16.50 - 20.00
Copper carbonate, bbl.	lb.	.20 - .20
Copper cyanide, drums	lb.	.50 - .55
Coppersulphate, crys., bbl.	100 lb.	6.00 - 6.25
Cream of tartar, bbl.	lb.	.25 - .26
Dextrine, corn, bags	100 lb.	3.25 - 3.50
Epsom salt, dom., tech. bbl.	100 lb.	2.10 - 2.25
Epsom salt, imp., tech. bags	100 lb.	1.10 - 1.25
Epsom salt, U.S.P., dom. bbl.	100 lb.	2.50 - 2.75
Ether, U.S.P., drums	lb.	.13 - .15
Ethyl acetate, com., 85% drums	gal.	.80 - .85
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	.95 - 1.00

Formaldehyde, 40% bbl.	lb.	\$0.15 - \$0.16
Fullers earth, f.o.b. mines, net ton	ton	16.00 - 17.00
Fullers earth—imp., powd., net ton	ton	30.00 - 32.00
Fusel oil, ref., drums	gal.	3.55 - 4.05
Fusel oil, crude, drums	gal.	2.30 - 2.40
Glaucous salt, wks., bags	100 lb.	1.20 - 1.40
Glaucous salt, imp., bags	100 lb.	1.00 - 1.25
Glycerine, c.p., drums extra	lb.	.18 - .19
Glycerine, dynamite, drums	lb.	.17 - .17
Iodine, resublimed	lb.	4.50 - 4.60
Iron oxide, red, casks	lb.	.12 - .18
Lead		
White, basic carbonate, dry, casks	lb.	.09 - .10
White, in oil, kegs	lb.	.12 - .13
Red, dry, casks	lb.	.11 - .11
Red, in oil, kegs	lb.	.13 - .14
Lead acetate, white crys., bbl.	lb.	.21 - .22
Lead arsenate, powd., bbl.	lb.	.21 - .22
Lime-Hydrated, bbl.	per ton	16.80 - 17.00
Lime, Lump, bbl.	280 lb.	3.63 - 3.65
Litharge, comm., casks	lb.	.09 - .10
Lithophone, bbl.	lb.	.06 - .07
Magnesium carb., tech., bags	lb.	.07 - .07
Methanol, 95% bbl.	gal.	1.23 - 1.25
Methanol, 97% bbl.	gal.	1.25 - 1.27
Nickel salt, double, bbl.	lb.	1.10 - 1.10
Nickel salts, single, bbl.	lb.	.11 - .11
Phosgene	lb.	.60 - .75
Phosphorus, red, cases	lb.	.35 - .40
Phosphorus, yellow, cases	lb.	.30 - .35
Potassium bichromate, casks	lb.	.09 - .10
Potassium bromide, gran., bbl.	lb.	.17 - .23
Potassium carbonate, 80-85%, calcined, casks	lb.	.06 - .06
Potassium chlorate, powd.	lb.	.07 - .08
Potassium cyanide, drums	lb.	.47 - .80
Potassium hydroxide (caustic potash) drums	100 lb.	7.25 - 7.50
Potassium iodide, cases	lb.	3.60 - 3.70
Potassium nitrate, bbl.	lb.	.06 - .07
Potassium permanganate, drums	lb.	.17 - .18
Potassium prussiate, red, casks	lb.	.85 - .90
Potassium prussiate, yellow, casks	lb.	.38 - .39
Salammoniac, white, gran., casks, imported	lb.	.06 - .06
Salammoniac, white, gran., bbl., domestic	lb.	.08 - .08
Gray, gran., casks	lb.	.08 - .08
Salsoda, bbl.	100 lb.	1.20 - 1.40
Salt cake (bulk)	ton	25.00 - 27.00
Soda ash, light, 58% flat, bags, contract	100 lb.	1.60 - 1.67
Soda ash, light, basis, 48% bags, contract, f.o.b.	100 lb.	1.20 - 1.30
Soda ash, light, 58% flat, bags, resale	100 lb.	1.75 - 1.80
Soda ash, dense, bags, contract, basis 48%	100 lb.	1.17 - 1.20
Soda ash, dense, in bags, resale	100 lb.	1.85 - 1.90
Soda, caustic, 76% solid, drums, f.a.s.	100 lb.	3.45 - 3.70
Soda, caustic, 76% solid, drums, contract	100 lb.	3.35 - 3.40
Soda, caustic, basis 60% wks., contract	100 lb.	2.50 - 2.60
Soda, caustic, ground and flake, contracts	100 lb.	3.80 - 3.90
Soda, caustic, ground and flake, resale	100 lb.	4.00 - 4.15
Sodium acetate, works, bags	lb.	.06 - .07
Sodium bicarbonate, bbl.	100 lb.	1.75 - 1.85
Sodium bichromate, casks	lb.	.07 - .08
Sodium bisulphate (niter cake) ton	ton	6.00 - 7.00
Sodium bisulphite, powd., U.S.P., bbl.	lb.	.04 - .04
Sodium chlorate, kegs	lb.	.06 - .07
Sodium chloride	long ton	12.00 - 13.00
Sodium cyanide, cases	lb.	.19 - .23
Sodium fluoride, bbl.	lb.	.09 - .10
Sodium hypsulphite, bbl.	lb.	.03 - .03
Sodium nitrite, casks	lb.	.08 - .09
Sodium peroxide, powd., cases	lb.	.28 - .30
Sodium phosphate, dibasic, bbl.	lb.	.03 - .04
Sodium prussiate, yel. drums	lb.	.19 - .19
Sodium silicate (40% drums)	100 lb.	.80 - 1.15
Sodium silicate (60% drums)	100 lb.	2.00 - 2.25
Sodium sulphide, fused, 60-62% drums	lb.	.04 - .04
Sodium sulphite, crys., bbl.	lb.	.03 - .03
Strontium nitrate, powd., bbl.	lb.	.09 - .10
Sulphur chloride, yel drums	lb.	.04 - .05
Sulphur, crude	ton	18.00 - 20.00
Sulphur dioxide, liquid, cyl.	lb.	.08 - .08
Sulphur, flour, bbl.	100 lb.	2.50 - 3.15

Sulphur, roll, bbl.	100 lb.	\$2.15 - \$2.20
Talc—imported, bags	ton	30.00 - 40.00
Talc—domestic powd., bags	ton	18.00 - 25.00
Tin bichloride, bbl.	lb.	.11 - .11
Tin oxide, bbl.	lb.	.45 - .47
Zinc carbonate, bags	lb.	.14 - .14
Zinc chloride, gran., bbl.	lb.	.07 - .07
Zinc cyanide, drums	lb.	.42 - .44
Zinc oxide, XX, bbl.	lb.	.07 - .08
Zinc sulphate, bbl.	100 lb.	2.75 - 3.00

Coal-Tar Products

Alpha-naphthol, crude, bbl.	lb.	\$0.85 - \$0.95
Alpha-naphthol, ref., bbl.	lb.	1.05 - 1.10
Alpha-naphthylamine, bbl.	lb.	.28 - .30
Aniline oil, drums	lb.	.16 - .17
Aniline salts, bbl.	lb.	.24 - .25
Anthracene, 80% drums	lb.	.75 - 1.00
Anthracene, 80% drums, duty paid	lb.	.65 - .70
Anthraquinone, 25% paste, drums	lb.	.70 - .75
Benzaldehyde U.S.P., carboys	lb.	1.35 - 1.40
Benzene, pure, water-white, tanks and drums	gal.	.30 - .35
Benzene, 90% tanks & drums	gal.	.26 - .32
Benzene, 90% drums, resale	gal.	.32 - .34
Benzidine base, bbl.	lb.	.85 - .90
Benzidine sulphate, bbl.	lb.	.75 - .80
Benzoic acid, U.S.P. kegs	lb.	.72 - .75
Benzoate of soda, U.S.P., bbl.	lb.	.57 - .65
Benzyl chloride, 95-97%, ref., drums	lb.	.25 - .27
Benzyl chloride, tech., drums	lb.	.20 - .23
Beta-naphthol, sublim., bbl.	lb.	.55 - .60
Beta-naphthol, tech., bbl.	lb.	.25 - .26
Beta-naphthylamine, tech.	lb.	1.00 - 1.25
Carbazol, bbl.	lb.	.76 - .90
Cresol, U.S.P., drums	lb.	.26 - .28
Ortho-cresol, drums	lb.	.24 - .26
Cresylic acid, 97% resale, drums	gal.	1.75 - 1.85
95-97% drums, resale	gal.	1.75 - 1.85
Diethylbenzene, drums	lb.	.07 - .09
Diethylaniline, drums	lb.	.40 - .60
Dimethylaniline, drums	lb.	.20 - .22
Dinitrobenzene, bbl.	lb.	.22 - .23
Dinitrochlorobenzene, bbl.	lb.	.30 - .32
Dinitronaphthalene, bbl.	lb.	.35 - .40
Dinitrophenol, bbl.	lb.	.22 - .24
Dinitrotoluene, bbl.	lb.	.22 - .30
Dip oil, 25% drums	gal.	.25 - .56
Diphenylamine, bbl.	lb.	.75 - .80
H-acid, bbl.	lb.	.95 - 1.00
Meta-phenylenediamine, bbl.	lb.	3.25 - 3.75
Miehlers ketone, bbl.	lb.	.08 - .10
Monochlorobenzene, drums	lb.	.95 - 1.10
Monooethylaniline, drums	lb.	.05 - .06
Naphthalene, crushed, bbl.	lb.	.06 - .06
Naphthalene, flake, bbl.	lb.	.07 - .07
Naphthalene, balls, bbl.	lb.	.58 - .65
Naphthionate of soda, bbl.	lb.	.60 - .65
Nitrobenzene, drums	lb.	1.10 - .12
Nitro-naphthalene, bbl.	lb.	.30 - .35
Nitro-toluene, drums	lb.	1.15 - .17
N-W acid, bbl.	lb.	1.15 - 1.20
Ortho-amidophenol, kegs	lb.	2.30 - 2.35
Ortho-dichlorobenzene, drums	lb.	.17 - .20
Ortho-nitrophenol, bbl.	lb.	.90 - .92
Ortho-nitrotoluene, drums	lb.	.12 - .14
Ortho-toluidine, bbl.	lb.	.14 - .16
Para-amidophenol, base, kegs	lb.	1.25 - 1.30
Para-amidophenol, HCl, kegs	lb.	1.30 - 1.35
Para-dichlorobenzene, bbl.	lb.	.17 - .20
Paranitraniline, bbl.	lb.	.73 - .75
Para-nitrotoluene, bbl.	lb.	.55 - .65
Para-phenylenediamine, bbl.	lb.	1.50 - 1.55
Para-toluidine, bbl.	lb.	.85 - .90
Phthalic anhydride, bbl.	lb.	.35 - .38
Phenol, U.S.P., drums	lb.	.35 - .37
Picric acid, bbl.	lb.	.20 - .22
Pyridine, dom., drums	gal.	nominal
Pyridine, imp., drums	gal.	3.00 - 3.10
Resorcinol, tech., kegs	lb.	1.50 - 1.55
Resorcinol, pure, kegs	lb.	2.00 - 2.10
R-salt, bbl.	lb.	.55 - .60
Salicylic acid, tech., bbl.	lb.	.40 - .42
Salicylic acid, U.S.P., bbl.	lb.	.45 - .47
Solvent naphtha, water-white, drums	gal.	.37 - .40
Crude, drums	gal.	.22 - .24
Sulphanilic acid, crude, bbl.	lb.	.20 - .22
Thiocarbamide, kegs	lb.	.35 - .38
Toluidine, kegs	lb.	1.20 - 1.30
Toluidine, mixed, kegs	lb.	.30 - .35
Toluene, tank cars	gal.	.35 - .37
Toluene, drums	gal.	.40 - .45
Xylidines, drums	lb.	.40 - .45
Xylene, pure, drums	gal.	.45 - .50
Xylene, com., drums	gal.	.40 - .42
Xylene, com., tanks	gal.	.30 - .35

Naval Stores

Rosin B-D, bbl.	280 lb.	\$5.75	
Rosin E-I, bbl.	280 lb.	5.90	
Rosin K-N, bbl.	280 lb.	6.10	\$6.35
Rosin W.G.-W.W., bbl.	280 lb.	7.75	8.25
Wood rosin, bbl.	280 lb.	6.25	
Turpentine, spirits of, bbl.	gal.	1.43	1.45
Wood, steam dist., bbl.	gal.	1.35	
Wood, dest. dist., bbl.	gal.	1.25	
Pine tar pitch, bbl.	200 lb.		6.00
Tar, kiln burned, bbl.	500 lb.		12.00
Retort tar, bbl.	500 lb.		11.00
Rosin oil, first run, bbl.	gal.	43	
Rosin oil, second run, bbl.	gal.	47	
Rosin oil, third run, bbl.	gal.	53	
Pine oil, steam dist., bbl.	gal.		90
Pine oil, pure, dest. dist., bbl.	gal.		85
Pine tar oil, ref., bbl.	gal.		46
Pine tar oil, crude, tanks f.o.b. Jacksonville, Fla.	gal.		35
Pine tar oil, double ref., bbl.	gal.		75
Pine tar, ref., thin, bbl.	gal.		25
Pinewood creosote, ref., bbl.	gal.		52

Vegetable Oils

Castor oil, No. 3, bbl.	lb.	\$1.12	\$1.12
Castor oil, AA, bbl.	lb.	1.12	1.13
Chinawood oil, bbl.	lb.	1.17	1.17
Cocunut oil, Ceylon, bbl.	lb.	.091	.09
Cocunut oil, Coochin, bbl.	lb.	.091	.10
Corn oil, crude, bbl.	lb.	1.11	1.11
Cottonseed oil, crude (f.o.b. mill), tanks.	lb.	.091	.10
Summer yellow, bbl.	lb.	1.12	1.12
Winter yellow, bbl.	lb.	1.13	1.13
Linseed oil, raw, ear lots, bbl.	gal.	.92	.93
Raw, tank cars (dom.), bbl.	gal.	.87	.88
Boiled, 5-bbl. lots (dom.), bbl.	gal.	.96	.97
Olive oil, denatured, bbl.	gal.	1.10	1.15
Palm, Lagos, casks, bbl.	lb.	.08	.081
Palm kernel, bbl.	lb.	.081	.09
Peanut oil, crude, tanks (mill), bbl.	lb.	1.13	1.13
Peanut oil, refined, bbl.	lb.	.16	.161
Rapeseed oil, refined, bbl.	gal.	.85	.86
Rapeseed oil, blown, bbl.	gal.	.90	.91
Soya bean (Manchurian), bbl.	lb.	1.11	
Tank, f.o.b. Pacific coast.	lb.	.10	

Fish Oils

Menhaden, light pressed, bbl.	gal.	\$0.60	
White bleached, bbl.	gal.	.64	.65
Blown, bbl.	gal.	.68	.69
Whale No. 1 crude, tanks, coast.	lb.	.06	.061

Dye & Tanning Materials

Divi-divi, bags.	ton	\$38.00	\$39.00
Fustic, sticks.	ton	30.00	35.00
Fustic, chips, bags.	lb.	.04	.05
Logwood, sticks.	ton	28.00	30.00
Logwood, chips, bags.	lb.	.021	.031
Sumac, leaves, Sicily, bags.	ton	65.00	
Sumac, ground, bags.	ton	55.00	60.00
Sumac, domestic, bags.	ton	35.00	
Tapioca flour, bags.	lb.	.031	.05

EXTRACTS

Archil, conc., bbl.	lb.	\$0.17	\$0.18
Chestnut, 25% tannin, tanks.	lb.	.02	.03
Divi-divi, 25% tannin, bbl.	lb.	.04	.05
Fustic, crystals, bbl.	lb.	.20	.22
Fustic, liquid, 42%, bbl.	lb.	.08	.09
Gambier, liq., 25% tannin, bbl.	lb.	.08	.09
Hematin, crys., bbl.	lb.	.14	.18
Hemlock, 25% tannin, bbl.	lb.	.04	.05
Hyperic, solid, drums.	lb.	.24	.26
Hyperic, liquid, 51%, bbl.	lb.	.14	.17
Logwood, crys., bbl.	lb.	.19	.20
Logwood, liq., 51%, bbl.	lb.	.09	.10
Quebracho, solid, 65% tannin, bbl.	lb.	.041	.05
Sumac, dom., 51%, bbl.	lb.	.061	.07

Waxes

Bayberry, bbl.	lb.	\$0.28	\$0.30
Beeswax, refined, dark, bags.	lb.	.30	.32
Beeswax, refined, light, bags.	lb.	.34	.35
Beeswax, pure white, cases.	lb.	.40	.41
Candelilla, bags.	lb.	.34	.35
Carnauba, No. 1, bags.	lb.	.38	.40
No. 2, North Country, bags.	lb.	.231	.24
No. 3, North Country, bags.	lb.	.171	.18
Japan, cases.	lb.	.15	.151
Montan, crude, bags.	lb.	.031	.04
Paraffine, crude, match, 105-110 m.p., bbl.	lb.	.04	.041
Crude, scale 124-126 m.p., bags.	lb.	.021	.021
Ref., 118-120 m.p., bags.	lb.	.031	.031
Ref., 125 m.p., bags.	lb.	.031	.031
Ref., 128-130 m.p., bags.	lb.	.041	.041
Ref., 133-135 m.p., bags.	lb.	.05	.051
Ref., 135-137 m.p., bags.	lb.	.10	.101
Stearic acid, agle pressed, bags.	lb.	.101	.101
Double pressed, bags.	lb.	.101	.101
Triple pressed, bags.	lb.	.11	.111

Fertilizers

Ammonium sulphate, bulk, f.o.b. works.	100 lb.	\$3.20	\$3.25
P.a.s. double bags.	100 lb.	3.85	3.95
Flood, dried, bulk.	unit	4.60	
Bone, raw, 3 and 50, ground.	ton	30.00	35.00
Fish scrap, dom., dried, wks.	ton	5.00	5.10
Nitrate of soda, bags.	100 lb.	2.60	2.65
Tankage, high grade, f.o.b. Chicago.	unit	4.70	4.80

Phosphate rock, f.o.b. mines, Florida pebble, 68-72%.	ton	\$3.50	\$4.00
Tennessee, 70-80%.	ton	7.00	8.00
Potassium muriate, 80%, bags.	ton	35.55	38.25
Potassium sulphate, bags.	unit	1.00	

Crude Rubber

Para-Upriver fine.	lb.	\$0.34	\$0.35
Upriver coarse.	lb.	.28	.28
Upriver cauchó ball.	lb.	.29	.30
Plantation—First latex crepe.	lb.	.35	.35
Ribbed smoked sheets.	lb.	.35	.35
Brown crepe, thin, clean.	lb.	.31	.32
Amber crepe No. 1.	lb.	.31	.32

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b., Quebec.	ah. ton	\$450.00	\$550.00
Asbestos, shingle, f.o.b., Quebec.	ah. ton	60.00	80.00
Asbestos, cement, f.o.b., Quebec.	ah. ton	15.00	17.00
Barytes, grd., white, f.o.b. mills, bbl.	net ton	16.00	20.00
Barytes, grd., off-color, f.o.b. mills bulk.	net ton	13.00	21.00
Barytes, floated, f.o.b. St. Louis, bbl.	net ton	24.00	28.00
Barytes, crude f.o.b. mines, bulk.	net ton	8.50	9.00
Casein, bbl., tech.	lb.	.11	.12
China clay (kaolin) crude, f.o.b. Ga.	net ton	7.00	9.00
Washed, f.o.b. Ga.	net ton	8.00	9.00
Powd., f.o.b. Ga.	net ton	13.00	20.00
Crude f.o.b. Va.	net ton	8.00	12.00
Ground, f.o.b. Va.	net ton	13.00	20.00
Imp., lump, bulk.	net ton	15.00	20.00
Imp., powd.	net ton	45.00	50.00
Feldspar, No. 1 pottery.	long ton	6.00	7.00
No. 2 pottery.	long ton	5.00	5.50
No. 1 soap.	long ton	7.00	7.50
No. 1 Canadian, f.o.b. mill.	long ton	25.00	27.00
Graphite, Ceylon, lump, first quality, bbl.	lb.	.06	.061
Ceylon, chip, bbl.	lb.	.05	.051
High grade amorphous crude.	ton	35.00	50.00
Gum arabic, amber, sorts, bags.	lb.	.15	.16
Gum tragacanth, sorts, bags.	lb.	.50	.60
No. 1, bags.	lb.	1.75	1.80
Kieselguhr, f.o.b. Cal.	ton	40.00	42.00
F.o.b. N. Y.	ton	50.00	55.00
Magnetite, crude, f.o.b. Cal.	ton	14.00	15.00
Pumice stone, imp., casks.	lb.	.03	.051
Dom., lump, bbl.	lb.	.05	.051
Dom., ground, bbl.	lb.	.06	.07
Shellac, orange fine, bags.	lb.	.84	.85
Orange superfine, bags.	lb.	.86	.87
A. C. garnet, bags.	lb.	.81	.82
T. N. bags.	lb.	.82	.83
Silica, glass sand, f.o.b. Ind.	ton	2.00	2.50
Silica, sand blast, f.o.b. Ind.	ton	2.50	5.00
Silica, amorphous, 250-mesh, f.o.b. Ill.	ton	17.00	17.50
Silica, bldg. sand, f.o.b. Pa.	ton	2.00	2.75
Soapstone, coarse, f.o.b. Vt., bags.	ton	7.00	8.00
Talc, 200 mesh, f.o.b. Vt., bags.	ton	6.50	9.00
Talc, 200 mesh, f.o.b. Ga., bags.	ton	7.00	9.00
Talc, 200 mesh, f.o.b. Los Angeles, bags.	ton	16.00	20.00

Refractories

Bauxite brick, 56% Al ₂ O ₃ , f.o.b. Pittsburgh.	ton	\$45-50	
Chrome brick, f.o.b. Eastern shipping points.	ton	50-52	
Chrome cement, 40-50% Cr ₂ O ₃ , 40-45% Cr ₂ O ₃ , sacks, f.o.b. Eastern shipping points.	ton	23-27	
Fireclay brick, 1st. quality, 9-in. shapes, f.o.b. Ky. wks.	1,000	40-46	
2nd. quality, 9-in. shapes, f.o.b. wks.	1,000	36-41	
Magnesite brick, 9-in. straight (f.o.b. wks.).	ton	65-68	
9-in. arches, wedges and keys.	ton	80-85	
Scraps and splits.	ton	85	
Silica brick, 9-in. sizes, f.o.b. Chicago district.	1,000	48-50	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.	1,000	48-50	
F.o.b. Mt. Union, Pa.	1,000	42-44	
Silicon carbide refract. brick, 9-in.	1,000	1,100.00	

Ferro-Alloys

Ferrotitanium, 15-18% f.o.b. Niagara Falls, N. Y.	ton	\$200.00	\$225.00
Ferromanganese, per lb. of Cr, 6-8% C.	lb.	.111	.111
4-6% C.	lb.	.12	.13
Ferromanganese, 78-82% Mn, Atlantic seab. duty paid.	gr. ton	105.00	107.50
Spiegeleisen, 19-21% Mn.	gr. ton	35.00	37.00
Ferromolybdenum, 50-60% Mo, per lb. Mo.	lb.	1.90	2.15
Ferro ilmen, 10-15% 50%.	gr. ton	38.00	40.00
75%.	gr. ton	80.00	85.00
	gr. ton	150.00	160.00

Ferrotungsten, 70-80%, per lb. of W.	lb.	\$0.90	\$0.95
Ferro-uranium, 35-50% of U, per lb. of U.	lb.	6.00	
Ferrovanadium, 30-40%, per lb. of V.	lb.	3.50	4.00

Ores and Semi-finished Products

Bauxite, dom. crushed, dried, f.o.b. shipping points.	ton	\$6.50	\$8.75
Chrome ore, Calif. concentrates, 30% min. Cr ₂ O ₃ , C. i. f. Atlantic seaboard.	ton	22.00	23.00
Coke, dry, f.o.b. ovens.	ton	18.50	19.00
Coke, furnace, f.o.b. ovens.	ton	9.25	9.50
Fluorspar, gravel, f.o.b. mines, New Mexico.	ton	8.00	8.50
Fluorspar, No. 2 Lump—Ky. & Ill. mines.	ton	17.50	
Ilmenite, 52% TiO ₂ .	lb.	25.00	
Manganese ore, 50% Mn, c. i. f. Atlantic seaboard.	unit	.011	.011
Manganese ore, chemical (Mn ₂).	ton	.30	
Molybdenite, 85% MoS ₂ , per lb. MoS ₂ , N. Y.	lb.	75.00	80.00
Monazite, per unit of ThO ₂ , c. i. f. Atl. seaboard.	lb.	.70	.75
Pyrites, Span., fines, c. i. f. Atl. seaboard.	unit	.06	.08
Pyrites, Span., furnace size, c. i. f. Atl. seaboard.	unit	.111	.12
Pyrites, dom. fines, f.o.b. mines, Ga.	unit	.111	.12
Rutile, 95% TiO ₂ .	lb.	.12	
Tungsten, scheelite, 60% WO ₃ and over, per unit.	unit	8.00	8.50
Tungsten, wolframite, 60% WO ₃ and over, per unit.	unit	7.50	8.00
Uranium ore (carnotite) per lb. of U ₃ O ₈ .	lb.	3.50	3.75
Uranium oxide, 96% per lb. U ₃ O ₈ .	lb.	2.25	2.50
Vanadium pentoxide, 99%.	lb.	12.00	14.00
Vanadium ore, per lb. V ₂ O ₅ .	lb.	1.00	
Zircon, washed, iron free, f.o.b. Pablo, Fla.	lb.	.041	.13

Non-Ferrous Materials

Copper, electrolytic.	Cents per lb.	13.00	
Aluminum, 98 to 99%.		22.00-23.00	
Antimony, wholesale, Chinese and Japanese.		7.15-7.50	
Nickel, virgin metal.		25.00-27.00	
Nickel, ingot and shot.		29.00	
Monel metal, shot and blooms.		32.00	
Monel metal, ingots.		36.00	
Monel metal, sheet bars.		39.875	
Tin, 5-ton lots, Straits.		8.00	
Lead, New York, spot.		7.90-8.00	
Lead, E. St. Louis, spot.		7.25-7.30	
Zinc, spot, New York.		6.90-7.05	
Zinc, spot, E. St. Louis.			

OTHER METALS

Silver (commercial).	oz.	\$0.64	
Cadmium.	lb.	1.15	
Bismuth (500 lb. lots).	lb.	2.50	
Cobalt.	lb.	3.00@3.25	
Magnesium, ingots, 99%.	lb.	1.00@1.05	
Platinum.	oz.	110.00	
Iridium.	oz.	250.00@275.00	
Palladium.	oz.	65.00@70.00	
Mercury.	75 lb.	72.50	

FINISHED METAL PRODUCTS

	Warehouse Price	
	Cents per lb.	
Copper sheets, hot rolled.	20.75	
Copper bottoms.	30.75	
Copper rods.	20.50	
High brass wire.	19.50	
High brass rods.	17.00	
Low brass wire.	21.10	
Low brass rods.	22.00	
Brased brass tubing.	24.25	
Brased bronze tubing.	29.00	
Seamless copper tubing.	25.25	
Seamless high brass tubing.	25.50	

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible.	11.30@11.50
Copper, heavy and wire.	11.25@11.50
Copper, light and bottoms.	9.25@9.50
Lead, heavy.	5.75@6.00
Lead, tea.	3.50@3.75
Brass, heavy.	6.25@6.40
Brass, light.	5.35@5.75
No. 1 yellow brass turnings.	6.30@6.50
Zinc.	3.50@4.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes.	\$3.29	\$3.14
Soft steel bars.	3.19	3.04
Soft steel bar shapes.	3.19	3.04
Soft steel bands.	3.29	3.19
Plates, 1/2 to 1 in. thick.	3.29	3.14

Industrial

Financial. Construction and Manufacturers' News

Construction and Operation

Arkansas

RITCHIE—The Arkansas Pipe Line & Navigation Co., Smackover, organized with a capital of \$5,000,000, is planning for the construction of a new oil storage and distributing plant in the vicinity of Ritchie. The initial tankage installation will consist of nine 20,000-bbl. and four 55,000-bbl. steel tanks. A similar plant is also contemplated at New Orleans, La. Grant Stebbins is president.

PINE BLUFF—The Pine Bluff Refining Co. is planning for the immediate installation of additional equipment at its local refining, including pressure stills and other apparatus, estimated to cost close to \$100,000.

SMACKOVER—F. M. Lege, Jr., and associates, Dallas, Tex., have organized a company to construct and operate a new oil storage and distributing plant at Lege, in the Smackover district, consisting of an initial capacity of 5,500,000 bbl., estimated to cost in excess of \$1,500,000, including operating equipment. A total of sixteen steel tanks will be installed.

California

SOUTH SAN FRANCISCO—The Metal & Thermit Corp., 120 Broadway, New York, manufacturer of Thermit welding apparatus, chemical and metal products, has plans in progress for the erection of a new local plant on Swift St., where a site of 14 acres is available. The works will consist of a number of buildings, with main rolling mill, estimated to cost in excess of \$1,000,000, with machinery. The Engineering Department, New York office, is in charge. E. W. Kardos is district manager, with office on Swift St., South San Francisco.

COALINGA—The Continental Petroleum & Refining Co. is arranging for the immediate construction of ten gasoline refining plants in different points of the San Joaquin Valley, estimated to cost close to \$1,000,000.

FRESNO—The Tyre Brothers Glass Co., 162 J St., is planning for the erection of a new building at its works to cost about \$27,000. Trewhitt & Shields, Rowell Bldg., are architects.

YUBA CITY—The King's Food Products Co., Salem, Ore., is negotiating with the local Chamber of Commerce for a site for the erection of a new hydrating plant, with initial unit estimated to cost approximately \$100,000, with machinery. A number of sites are said to be under consideration. R. G. Grant is representative for the company.

NAPA—The Mercury Oil Co. will commence the immediate erection of a new oil storage and distributing plant at East Napa, estimated to cost approximately \$35,000.

ANTIOCH—The Paraffine Companies, Inc., 34 1st St., San Francisco, will call for bids early in February for the erection of a new plant building at Antioch, estimated to cost close to \$40,000. Leland Rosener, Insurance Bldg., San Francisco, is architect.

Florida

SOUTH JACKSONVILLE—C. S. Burgess, 423 Cornelia St., is considering the establishment of a local plant for the production of oils and extracts from citrus fruits. Inquiries are being made for suitable machinery.

Idaho

PAYETTE—Danney & Co. have tentative plans under consideration for the rebuilding of their fruit evaporator plant, recently destroyed by fire with loss approximating \$35,000.

Illinois

CHICAGO—L. Mitchell & Co., 1314 East 61st St., manufacturers of washing compounds, chemical products, etc., have purchased property, 225x300 ft., at Ellis Ave. and 83rd St., as a site for a new plant. No

date for erection has as yet been set, and tentative plans only will be developed for the present. Frederick G. Mitchell is head.

CICKEN—The American 3-Way Prism Co., 1305 South 55th Ct., manufacturer of glass products, has tentative plans under consideration for the erection of a new 1-story plant at Roosevelt Ave. and 65th Ct., 215x300 ft. An architect to prepare detailed drawings will be selected in the near future. C. H. Paschall is president.

Indiana

SEYMOUR—The Blish Milling Co. has plans in preparation for the erection of a new plant for the manufacture of oils from soy beans. A complete extraction works will be installed. The plant is estimated to cost close to \$35,000, including machinery. John A. Shields is secretary.

Iowa

BURLINGTON—The Burlington Glass Co., 315 Tama Bldg., is considering plans for the erection of a new plant on North Main St., to be 1- and 2-story, 150x450 ft., estimated to cost approximately \$250,000, including machinery. W. A. Rayburn is president.

Louisiana

LAFAYETTE—The Star Salt Co. has commenced the construction of a new plant at its works, to be equipped primarily for the evaporation of salt from the brine as pumped from the wells. It will have an initial capacity of about 200 tons per week, and is estimated to cost in excess of \$55,000. John J. Kean is general manager.

Maryland

PINESBURG—The Keystone Limestone Co. has acquired the local limestone properties of the Potomac Valley Stone & Lime Co., Pinesburg, near Hagerstown, comprising about 165 acres of land, for a consideration of \$65,000, and plans for the installation of plant and extensive operations.

HAGERSTOWN—The Hagerstown Lime & Chemical Co. is perfecting plans for the construction of its proposed local plant for the manufacture of agricultural lime and kindred products, and will call for construction bids in about 30 days. The plant will include a complete grinding and pulverizing works, with daily capacity of about 100 tons. J. S. Myers is president.

Michigan

LUDINGTON—The Morton Salt Co., 80 East Jackson Blvd., Chicago, Ill., has acquired the local plant and property of the Stearns Salt & Lumber Co., with capacity of 500,000 bbl. per annum. The purchasing company also operates a plant at Ludington, as well as at Port Huron, and plans to construct a large addition to the Ludington works, discontinuing operations at the Stearns plant. The plant of the Morton company has a present rated capacity of 1,000,000 bbl. per year.

RIVER ROUGE—The Ford Motor Co., Highland Park, is taking bids for the construction of a new 1-story foundry at River Rouge, to be used for automotive casting production. Albert Kahn, 1000 Marquette Bldg., Detroit, is architect.

MANISTEE—The Filer Fibre Co., Filer City (recently incorrectly noted under Manistee, Mass.) has construction under way on a new local plant and will commence the machinery installation at an early date. The mill will be equipped to give employment to about 100 operatives. M. Oberdorfer is vice-president.

Mississippi

GULFPORT—The Gulf Coast Refining Co. has tentative plans under consideration for the construction of an addition to its local plant for considerable increase in production.

Missouri

FLAT RIVER—The Federal Lead Co. is reported to be planning for the construction of a new mill in the Dobson section,

vicinity of Hockerville, Okla., where property has recently been acquired. The company also has plans under consideration for taking over the Bunker Hill properties in this same district.

KANSAS CITY—The Phillips-Morgan Estates, 607 Ridge Bldg., has plans in progress for the construction of a new paper mill, to consist of two main buildings, each 50x220 ft., estimated to cost close to \$70,000. The general contract will be handled by the D. H. Greene Construction Co., same address. L. L. Morgan is president.

New Jersey

BAYONNE—The Ingram-Richardson Mfg. Co., Beaver Falls, Pa., manufacturer of enameled iron signs, will soon commence the erection of a new plant at Bayonne, comprising a main 1-story building, 181x325 ft., estimated to cost more than \$60,000, with equipment. The A. M. Allen Co., 7016 Euclid Ave., Cleveland, O., is architect. Ernest Richardson is vice-president and treasurer.

NEWARK—The Martin Metals Corp. has leased a portion of the 4-story building at 115-17 Monroe St., owned by the Foster Engineering Co., for the establishment of a new foundry for the manufacture of aluminum and other metal castings.

NEWARK—The Nickelsburg Brothers Co., Meadow Ave., near the Lincoln Highway, has tentative plans under consideration for the enlargement of its leather tanning and manufacturing plant for considerable increase in capacity. The company has recently been disposing of a preferred stock issue of \$1,000,000, a portion of the proceeds to be used for the proposed expansion.

TRENTON—The Reading Rubber Co., recently organized under state laws with a capital of \$250,000, with initial paid-in capital of \$51,000, has preliminary plans under way for the erection of a new plant on local site, replacing its present works at Kutztown, Pa. Negotiations are said to be in progress for the purchase of the land. The company is headed by Frank C. Myers, Trenton; Samuel H. Bell, Reading, Pa.; and Jesse P. Stiles, Allentown, Pa. It is represented by Maxwell A. Kraemer, American Mechanic Bldg., Trenton.

BAYONNE—The National Sulphur Co., 80 Maiden Lane, New York, announces that the addition to its plant at North Akron, O., which was reported in these columns last week, is for the purpose of increased operations in that city and it is not the company's intention to vacate or lessen in any way its activities at the present works in Bayonne.

TRENTON—Officials of the Traveler Rubber Co., Bethlehem, Pa., headed by Guy de la Rigaudiere, president, have acquired a substantial interest in the United & Globe Rubber Co., Prospect and Frazier Sts., Trenton, and have organized a new company under the same name, with larger capitalization, to take over and operate the present business, devoted to the manufacture of mechanical rubber goods, automobile tires, etc. Extensions and improvements in the works are under consideration. John S. Broughton, president of the former organization, has been elected chairman of the board; Mr. de la Rigaudiere, president; and Victor Durand, Jr., 1st vice-president.

New York

LONG ISLAND CITY—The A. C. Horn Co., Bodine St., manufacturer of waterproofing products, technical coatings, etc., has purchased property on Hancock St., near 14th St., approximating 30,000 sq.ft., for proposed extensions.

HUDSON—The Knickerbocker Portland Cement Co. has awarded a contract to the Turner Construction Co., 242 Madison Ave., New York, for foundations and other work in connection with an addition to its local cement mill.

BUFFALO—The Williams Gold Refining Co., 2978 Main St., has work under way on extensions and improvements in its plant, estimated to cost about \$15,000.

WATERFORD—The Goodyear Tire & Rubber Co., Akron, O., has acquired local property, heretofore occupied by the Beaver Mills Co., with option to purchase, for the establishment of a new branch plant for the manufacture of tires and other rubber products.

NEW YORK—The International Paper Co., 30 Broad St., has tentative plans under consideration for the construction of a large paper mill and hydro-electric power plant for operating service, at Grand Falls, N. B., estimated to cost in excess of \$5,000,000.

Ohio

CLEVELAND—The Forest City Foundry & Mfg. Co., 1220 Main Ave., N. W., special-

izing in the production of small gray-iron castings, has tentative plans under consideration for the erection of a new 1-story foundry at Maywood Ave. and West 90th St., estimated to cost close to \$400,000, with equipment. Albert Gerdum is president.

Oklahoma

TONKAWA—The Champlin Oil & Refining Co., Enid, Okla., has acquired a tract of local property, comprising about 45 acres of land, as a site for the construction of a new oil refining plant. Plans will be prepared at early date.

ARDMORE—The Hewitt Refining Co., recently organized with headquarters at Ardmore, is perfecting plans for the immediate erection of a new oil-refining plant on site secured at Wilson, near Ardmore, with initial capacity of about 1,500 bbl. per day. It is estimated to cost in excess of \$200,000, with machinery. C. E. Sykes is president, and Ross W. Coe, secretary and treasurer.

TONKAWA—The Golden Rule Refining Co., Wichita, Kan., is planning for the construction of a new local oil refinery, estimated to cost approximately \$100,000. A tract of property has been purchased.

TONKAWA—The Constantin Refining Co., Tulsa, has plans in progress for the construction of a new refining plant on 50-acre tract of land here, lately acquired. The refinery will be used for the production of refined petroleum, lubricating oils, etc.

Pennsylvania

PHILADELPHIA—The Philadelphia Paper Mfg. Co., River Rd., has awarded a general contract to the J. S. Rogers Co., Drexel Bldg., for the construction of a new 5-story building at Randolph and Willow Sts., estimated to cost approximately \$225,000.

YORK HAVEN—The Conewago Felt & Paper Co., recently organized with a capital of \$300,000, is perfecting plans for the erection of the initial unit of its proposed new local plant, to be 1-story, 35x170 ft. A site has been selected. Hamme & Witman, City Bank Bldg., York, Pa., are architects. E. E. Brunner, president of the York Haven State Bank, is head of the new company.

OIL CITY—The Penn-American Refining Co. has work under way on extensions at its local gasoline refinery, for considerable increased output. A 3-unit cracking plant will be installed.

South Carolina

COLUMBIA—The Southern Silica Mining & Mfg. Co., 1643 Main St., is planning for the installation of additional mechanical sand drying equipment at its plant, with capacity of about 150 tons per day. Inquiries are out for the apparatus.

Tennessee

RICHARD CITY—The Dixie Portland Cement Co., Chattanooga, has tentative plans under consideration for extensions and improvements in its local cement manufacturing plant, estimated to cost about \$175,000, including machinery.

Texas

BLOSSOM—The Blossom Oil & Cotton Co. is reported to be planning for the rebuilding of the portion of its local cotton oil mill, destroyed by fire, Jan. 13, with loss approximating \$60,000. The reconstruction is estimated to cost a like amount. Additional equipment will be installed.

HOUSTON—The Magnolia Paper Co. has plans in progress for the erection of an addition to its local paper mill, estimated to cost approximately \$75,000.

ROTAN—J. W. Patton, operating a local lime plant, has disposed of a portion of his property to the Universal Gypsum Co., which plans for the early erection of a new plant for the manufacture of cement, wall-board and other gypsum products. It is estimated to cost close to \$75,000, with machinery, and will give employment to about 125 men at the start. C. E. Williams is an official of the purchasing company.

Virginia

ROANOKE—The Cement Products Mfg. Corp., recently organized with a capital of \$30,000, has plans in progress for the erection of a new plant on local site for the manufacture of cement products, including tile, shingles, blocks, etc. Ground will be broken at an early date. E. A. Buchanan, P. O. Box 1172, is secretary and general manager.

WINCHESTER—The National Fruit Product Co., manufacturer of vinegar and other

apple byproducts, is planning for extensions in its plant to double the present output. A new tank department will be installed with total capacity of 2,500,000 gal. C. E. Koontz is manager.

PETERSBURG—The Dodge Leather Co. has tentative plans under consideration for the erection of an addition to its plant for considerable increase in capacity. L. F. Dodge is president.

SOMERSET—The Rapidan Soapstone Corp., Orange, Va., recently organized with a capital of \$200,000, has plans under consideration for the erection of a new plant on property acquired in the vicinity of Somerset. Kesse Brookings is president, and D. N. Davidson secretary and treasurer.

PETERSBURG—The Capitol Oil Co., Union Trust Bldg., recently organized, will soon commence the erection of a new oil storage and distributing plant, estimated to cost about \$40,000.

West Virginia

SOUTH CHARLESTON—The Westvaco Chemical Co., Charleston, is planning for the construction of an addition to its South Charleston works, to consist of a complete operating unit, estimated to cost close to \$50,000. The structure will be used for the conversion of brine products into chemicals. F. J. Kaufman is general manager.

CHARLESTON—Foundations are under way for the erection of the proposed 1 story addition to the local plant of the Owens Bottle Co., to be 120x200 ft., estimated to cost approximately \$150,000. Other additions will be made at a later date. Headquarters of the company are in the Nicholas Bldg., Toledo, O.; the Devore Co., same address, is engineer.

Wyoming

CLATTON—The Sinclair Crude Oil Producing Co., affiliated with the Sinclair Consolidated Oil Corp., 45 Nassau St., New York, will commence the erection of a new local storage and distributing plant comprising thirty 80,000-bbl. capacity steel tanks and auxiliary equipment.

Industrial Developments

LEATHER—Dungan, Hood & Co., Philadelphia, Pa., are running their tanneries at close to 75 per cent of normal.

The Premier Leather Co., Boston, Mass., has resumed the production of black and colored glazed kid at its Philadelphia, Pa., plant, and expects to gradually advance manufacture in this line.

Robert H. Foerderer, Inc., Philadelphia, Pa., specializing in the production of glazed kid, is operating at its Frankford tannery at about 75 per cent of capacity.

CERAMIC—The Western Brick Co., Danville, Ill., is maintaining capacity production at its plant, giving employment to about 400 operatives. The wage scale has recently been advanced.

The Champion Spark Plug Co., Toledo, O., is now operating on a production basis of 120,000 spark plugs per working day, or on a schedule of 271 a minute. A full working force is being employed. The plant is said to be the largest in the world devoted to this line of manufacture.

The Mapleton Clay Products Co., Mapleton, O., specializing in the manufacture of face brick, is developing capacity operations and expects to be running on a basis of 45,000 bricks daily at an early date. This schedule will be maintained for an indefinite period.

The Birmingham Clay Products Co., Birmingham, Ala., manufacturer of brick, is running on a full-time schedule at its local plant, giving employment to the regular working force. The company has work under way for a new kiln room for general increase in capacity, and is also considering the erection of other plant additions.

The Southern Brick & Tile Co., Louisville, Ky., is arranging for the early resumption of operations at its plant, recently closed down for necessary repairs. A close to normal working force will be employed.

The I. L. Stiles & Son Brick Co., North Haven, Conn., is operating on a basis of about 60,000 bricks per day at its local plant, and is installing additional mechanical drying equipment to provide for further output.

Terra cotta plants in the Chicago, Ill., district are operating at maximum capacity with full working forces. A number of

the plants are booked with orders insuring the continuance of this schedule well into spring.

The Louisville Fire Brick Works, Louisville, Ky., is operating its local plant at approximately 65 per cent of normal capacity. The branch plant at Grahn, Ky., is maintaining approximately this same schedule.

The Alton Brick Co., Alton, Ill., is planning for the early resumption of operations at the plant of the Banner Clay Works, Edwardsville, Ill., recently acquired. A portion of the plant is being remodeled and improved, and additional equipment will be installed.

GLASS—The National Glass Co., Shreveport, La., manufacturer of window glass, has perfected plans for the immediate reopening of its plant, giving employment to about 250 operatives. The works have been closed for some time past.

The Owens Bottle Co., Toledo, O., is running on a capacity basis at all of its plants, and expects to continue on this basis for some time to come. Full working forces are being employed.

RUBBER—The Woonsocket Rubber Co., Woonsocket, R. I., a division of the United States Rubber Co., has announced a full-time working schedule, effective Feb. 1, until further notice; it is expected that this basis will be continued throughout the year. At the same time the company has advanced wages at the plant, as well as at the branch factory at Millville, Mass., affecting about 1,900 operatives.

The B. F. Goodrich Co., Akron, O., has acquired the plant of the Ames-Holden Tire Co., Kitchener, Ont., for increased production for Canadian trade. The plant has a rated capacity of 1,000 tires a day and will immediately be placed on this full-production basis for a full line of Goodrich tires. The company is maintaining full operations at its main works at Akron, O.

The Boston Rubber Shoe Co., Malden, Mass., a branch of the United States Rubber Co., has advanced the wages of employees at the local mill. Employment is now being given to close to 2,000 persons.

CEMENT—The Atlas Portland Cement Co., New York, is arranging for an early increase in production at its mills in different parts of the country, placing all plants on a full-capacity basis for the first time since 1914. The No. 3 plant at Northampton, Pa., has already adopted a maximum output schedule, with capacity of 10,000 bbl. per day. Other plants of the company are located at Hudson, N. Y.; Hannibal, Mo.; Leeds, Ala.; and Coplay, Pa.

The majority of the cement mills in the Lehigh Valley district of Pennsylvania are running on a full turn, giving employment to regular working forces. This schedule will be maintained for an indefinite period.

Riggers at the plant of the Alpha Portland Cement Co., Martin's Creek, Pa., declared a strike, Jan. 22, when a demand for an advance in wages from 44 to 65 cents an hour was refused by the company. The men are still out.

IRON AND STEEL—The Algoma Steel Corp., Sault Ste. Marie, Ont., is arranging to resume operations at its local mills before the close of February. The plant has been closed down for some weeks past.

The Wickwire-Spencer Steel Corp., Buffalo, N. Y., is operating at capacity at all plants, with a day and night working schedule. The Worcester, Mass., mills are giving employment to 3,500 men and are declining immediate orders at the maximum production is not equal to the demand.

The Alan Wood Iron & Steel Co., Conshohocken, Pa., has advanced the working time at its Ivy Rock blooming mill from 5 to 6 days a week, with day and night operating forces.

The Temple blast furnace, Temple, Pa., now under new management, has repairs and improvements under way at the stack, and expects to blow in during March. The furnace has been idle for about 24 months past.

The American Sheet & Tin Plate Co., Pittsburgh, Pa., has advanced production at its Wheeling, W. Va., works, bringing the average production of the different plants to 90 per cent of capacity. It is said that labor shortage will not permit an increase over this schedule at the present time. All plants of the company are on the active list.

Steel mills in the Chicago, Ill., district continue to advance production and the leading plants are now running on a basis of 80 to 85 per cent of capacity, as compared with 75 to 80 per cent a month ago.

In accordance with its proposed schedule the Thomas Iron Co. has blown in its new blast furnace at Hokendaqua, Pa., with

rated capacity of 400 tons of pig iron daily. The organization recently came under the control of the Reading Iron Co., of which L. E. Thomas is president.

MISCELLANEOUS—The American Cellulose & Chemical Mfg. Co., Ltd., Amcelle, Md., is perfecting arrangements for the early resumption of operations at its local plant, which has been closed for some time past.

The Standard Oil Co. of New Jersey has refused the demand of employees at its three refineries at Constable Hook, Bayonne; Bayway and Eagle Works, Jersey City, N. J., for a wage increase. It is pointed out that the increase in average hourly earnings at the plants from 1914 to the present time has been approximately 190 per cent.

Capital Increases, etc.

THE WHITEHEAD BROTHERS RUBBER CO., Whitehead Rd., Trenton, N. J., manufacturer of mechanical rubber products, has filed notice of increase in capital from \$60,000 to \$180,000.

THE PAN-AMERICAN PETROLEUM & TRANSPORT CO., 120 Broadway, New York, operating oil refineries in Mexico, California and other locations, has arranged for an increase in capital from \$150,000,000 to \$230,000,000 for general expansion.

THE MICHIGAN GREY IRON CASTINGS CO., Harbough St., Detroit, Mich., has filed notice of increase in capital from \$10,000 to \$250,000 for proposed expansion.

THE BROWN CO., Berlin, N. H., manufacturer of paper and sulphite products, is disposing of a bond issue of \$2,500,000, a portion of the proceeds to be used for general operations, additions to working capital, etc.

THE LAKE VIEW BRICK CO., 2758 Irving Park, Chicago, Ill., has arranged for an increase in capital from \$50,000 to \$200,000, a portion of the proceeds to be used for expansion and additions to working capital.

GEORGE D. WETHERILL & CO., INC., 113 Arch St., Philadelphia, Pa., manufacturers of paints, white lead, etc., are arranging for an increase in capital from \$500,000 to \$3,000,000 for general expansion.

THE DETROIT RUBBER PRODUCTS CO., INC., 565 East Jefferson St., Detroit, has filed notice of increase in capital from \$50,000 to \$125,000.

THE BLOOMSBURY GRAPHITE CO., Bloomsbury, N. J., has arranged for an increase in capital from \$50,000 to \$100,000.

THE KALAMAZOO SANITARY MFG. CO., Kalamazoo, Mich., manufacturer of sanitary earthenware products, has filed notice of increase in capital from \$350,000 to \$700,000.

New Companies

THE BRETTLE-BAKER CO., Lynn, Mass., has been incorporated with a capital of \$10,000, to manufacture liquid rubber cement, waxes, etc. Lorenz F. Muther is president; and William L. Newton, 362 Massachusetts Ave., Boston, treasurer.

THE HOOSIER RENDERING CO., Kentland, Ind., has been incorporated with a capital of \$25,000, to manufacture fertilizer products. The incorporators are Egbert S. Hess, Rufus Robinson and Samuel L. Barnhard, all of Kentland.

THE NITRO CHEMICAL PRODUCTS CORP., New York, N. Y., care of J. M. Kram, 51 Chambers St., New York, representative, has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are C. Leventhal, N. Gray and B. Sustrain.

THE GENERAL SMELTING & REFINING CO., Detroit, Mich., has been incorporated with a capital of \$10,000, to operate a metal smelting and refining plant. The incorporators are Daniel Temchin and Samuel Cooper, 678 Leland Ave., Detroit.

THE HUDSON FIREPROOF BLOCK CO., North Bergen, N. J., has been incorporated with a capital of \$300,000, to manufacture burned clay building blocks and kindred ceramic products. The incorporators are John E. Toolam, David T. Wilents and Leon E. McElroy, Garden St., North Bergen.

THE GENERAL PETROLEUM CO., 203 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are Frank Tillotson, I. N. Walker and O. E. Edfast.

THE PEACE CHEMICAL CO., Phillipi, W. Va., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are H. B. Grant, Sherman Lindsey and B. E. Snyder, all of Phillipi.

THE UNITED PROTECTIVE COATINGS CORP., New York, N. Y., care of J. J. Finn, attorney, Yonkers, N. Y., representative, has been incorporated with a capital of \$50,000, to manufacture paints and special coatings. The incorporators are C. R. Douglas and M. F. Cole.

THE BENTON HARBOR CHEMICAL CO., Benton Harbor, Mich., has been incorporated with a capital of \$10,000, to manufacture chemicals and special chemical preparations. The incorporators are Walter S. Burgess, H. J. Dunleavy and A. L. Hogue, all of Benton Harbor.

THE ENTERPRISE LIME & BALLAST CO., 14 Green St., Cumberland, Md., has been incorporated with a capital of \$100,000, to manufacture lime and affiliated products. The incorporators are Charles E. Schaidt, William M. Somerville and Harry R. Donnelly.

THE BERGER LEVY CO., New York, N. Y., care of Bloomberg & Bloomberg, 1482 Broadway, New York, representatives, has been incorporated with a capital of \$100,000, to manufacture glassware specialties. The incorporators are H. A. and E. N. Bloomberg, and W. Kaufman.

THE APEX SMELTING CO., 180 North Market St., Chicago, Ill., has been incorporated with a capital of \$60,000, to operate a metal smelting plant. The incorporators are William Helfand, Samuel Berenbaum and Sidney E. Levy.

THE SHELBY IRON & CHEMICAL CO., Memphis, Tenn., care of the Delaware Registration Trust Co., 900 Market St., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$1,000,000, to operate iron properties, by-product chemical works, etc. The incorporators are M. N. Harris, H. W. Dow and C. D. Shelow, Memphis.

THE FRENCH MICA CO., 208 Broad St., Elizabeth, N. J., has been incorporated with a capital of \$10,000, to manufacture mica products. The incorporators are Russell W. Leary, Malcolm W. Clephane and Donald McL. Somers.

THE SERVICE GLASS CO., Detroit, Mich., has been incorporated with a capital of \$10,000, to manufacture glass products. The incorporators are E. F. Kellum, Roland H. Newton and George W. Clay, 2049 Poplar St.

THE VITROLITE PRODUCTS CO., Buffalo, N. Y., care of Kent, Cummings & Means, Dun Bldg., Buffalo, representative, has been incorporated with a capital of \$55,000, to manufacture composition materials for table tops, etc. The incorporators are F. E. Beluche, C. DeF. Cummings and G. A. Brenner.

THE HOFFMAN BROTHERS TANNING CO., 4701 Grand Ave., Chicago, Ill., has been incorporated with a capital of \$250,000, to operate a leather tanning plant. The incorporators are Olaf C. and Anton R. Hoffman, and Carl Peterson.

THE PITTSBURGH LEATHER & GLUE CO., Pittsburgh, Pa., care of W. F. Stadlander, 415 Frick Bldg., Pittsburgh, representative, is being organized under state laws to manufacture glue and adhesives, leather products, etc.

THE PACIFIC BRICK & TILE CO., 5233 Alhambra Ave., Los Angeles, Cal., has filed notice of organization to manufacture brick, tile and affiliated burned clay products. The company is headed by Carl B. Gallasch and Claude S. Kerrick.

THE DIXIE DISINFECTING CO., Dallas, Tex., has been incorporated with a capital of \$10,000, to manufacture chemical disinfectants, etc. The incorporators are E. J. and O. S. Boyd, and S. P. Solomonson, all of Dallas.

THE CHEROKEE BRICK CO., Knoxville, Tenn., care of the Delaware Corporation Co., Ford Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$250,000, to manufacture burned clay products, including brick, tile, etc. The incorporators are R. G. and J. C. Wright, and C. E. Campbell, Jr., all of Knoxville.

THE HANNIGAN WATERPROOFING & MFG. CO., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture waterproofing compounds, paints, etc. The incorporators are C. R. Buell, E. Kazemier and T. P. Hannigan, 51 Chambers St., New York. The last noted represents the company.

THE REGISTER OIL CORP., care of the Delaware Registration Trust Co., 900 Market St., Wilmington, Del., representative, has been incorporated under Delaware laws, with a capital of \$100,000, to manufacture petroleum products.

THE ADENZIT CO., Long Island City, N. Y., care of J. K. Gillette, 424 Steinway Ave., Long Island City, representative, has been incorporated with a capital of \$15,000, to

manufacture chemicals and chemical compounds. The incorporators are T. Moore, W. C. and I. W. Kober.

THE R. A. MOORE LEATHER CO., Greenville, Tex., has been incorporated under state laws to manufacture leather products. The incorporators are R. A. Moore, J. M. Massey and W. N. Miller, all of Greenville.

THE ALUMINUM FOUNDRY CO., Boston, Mass., has been incorporated with a capital of \$10,000, to manufacture aluminum, bronze and other metal castings. Harry D. Finberg is president and Abraham Sherman, 138 Gaston St., Roxbury, Mass., treasurer.

THE PETERS PETROLEUM CORP., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$1,000,000, to manufacture petroleum products.

THE LAKESIDE OIL REFINING CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$5,547,500, to manufacture refined petroleum products.

THE SOBRITE CHEMICAL CO., 236 7th St., Jersey City, N. J., has filed notice of organization to manufacture polishes, etc. G. L. Shoemaker heads the company.

Coming Meetings and Events

AMERICAN ASSOCIATION OF ENGINEERS will hold its annual convention in Norfolk, Va., May 7 to 9.

AMERICAN CERAMIC SOCIETY will hold its annual meeting in Pittsburgh, Pa., Feb. 12 to 17, 1923.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting May 3, 4 and 5, 1923, at the Commodore Hotel, New York.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold a meeting in Cleveland, O., April 28 to May 4.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its annual meeting in New York City during the week of Feb. 19, 1923.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its twentieth annual convention at the Greenbrier, White Sulphur Springs, W. Va., June 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its winter sectional meeting in the City Club, Chicago, Feb. 8 and 9, 1923.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-sixth annual meeting at the Chalfonte-Haddon Hall Hotel, Atlantic City, beginning Monday, June 25, 1923, and ending either Friday or Saturday of that week.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL FOREIGN TRADE COUNCIL has postponed its annual conference from April 25, 26 and 27, to May 2, 3 and 4. It will be held in New Orleans, La.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS, with headquarters in Chicago, will hold its spring convention in Cincinnati, April 18, 19 and 20, 1923. The major subject will be "Management Problems of the Smaller Plants."

A PAPER INDUSTRIES EXPOSITION will be held in Grand Central Palace, New York City, during the week of April 9, 1923, by the International Exposition Co.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, East 41st St., New York City: Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.